Appendix E

Traffic Analysis Worksheets

2018 Opening Year

Build River Center Site Alternatives 5-7

Interstate 526

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information   Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3010-EB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	340
Freeway Volume, V_F	2645
Ramp Volume, V_R	28
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2645	0.90	Level	4	0	0.980	1.00	2998
Ramp	28	0.90	Level	36	0	0.847	1.00	37
UpStream								
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12}	Estimation of v_{12}

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   2998 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity	LOS F?		Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8		V_F	2998	Exhibit 13-8 4600	No
				$V_{FO} = V_F - V_R$	2961	Exhibit 13-8 4600	No
				V_R	37	Exhibit 13-10 2100	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?		Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8		V_{12}	2998	Exhibit 13-8 4400:All	No

Level of Service Determination (if not F) | Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   27.0 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Speed Determination | Speed Determination

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

D_s =   0.301 (Exhibit 13-12)

S_R =   54.6 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   54.6 mph (Exhibit 13-13)

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F-3913

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3010-EB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description	Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	340
Freeway Volume, V_F	2539
Ramp Volume, V_R	55
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2539	0.90	Level	3	0	0.985	1.00	2863
Ramp	55	0.90	Level	15	0	0.930	1.00	66
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} | Estimation of v_{12}

$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$

	Merge		Diverge
L_{EQ} =	(Equation 13-6 or 13-7)	L_{EQ} =	(Equation 13-12 or 13-13)
P_{FM} =	using Equation (Exhibit 13-6)	P_{FD} =	1.000 using Equation (Exhibit 13-7)
V_{12} =	pc/h	V_{12} =	2863 pc/h
V_3 or V_{av34}	pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34}	0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No		Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No	
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No		Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No	
If Yes,V_{12a} =	pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} =	pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity	LOS F?		Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		V_F	2863	Exhibit 13-8	4600	No
				$V_{FO} = V_F - V_R$	2797	Exhibit 13-8	4600	No
				V_R	66	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?		Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		V_{12}	2863	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) | Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 25.8 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = C (Exhibit 13-2)

Speed Determination | Speed Determination

M_S = (Exibit 13-11)	D_s = 0.304 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 54.5 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = N/A mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 54.5 mph (Exhibit 13-13)

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F-3914

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3020-EB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N — 2		☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N — 1		☑ No ☐ Off
	Acceleration Lane Length, L_A		
L_{up} = ft	Deceleration Lane Length L_D — 600		L_{down} = ft
	Freeway Volume, V_F — 2617		
V_u = veh/h	Ramp Volume, V_R — 178		V_D = veh/h
	Freeway Free-Flow Speed, S_{FF} — 60.0		
	Ramp Free-Flow Speed, S_{FR} — 25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2617	0.90	Level	10	0	0.952	1.00	3053
Ramp	178	0.90	Level	8	0	0.962	1.00	206
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3053 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	3053	Exhibit 13-8 — 4600	No
$V_{FO} = V_F - V_R$	2847	Exhibit 13-8 — 4600	No
V_R	206	Exhibit 13-10 — 1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	3053	Exhibit 13-8 — 4400:All	No

Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 25.1 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = C (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = (Exibit 13-11)	D_s = 0.577 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 49.6 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = N/A mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 49.6 mph (Exhibit 13-13)

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F-3915

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3020-EB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	2	☐ Yes ☐ On	
☑ No ☐ Off	Ramp Number of Lanes, N	1	☑ No ☐ Off	
	Acceleration Lane Length, L_A			
L_{up} = ft	Deceleration Lane Length L_D	600	L_{down} = ft	
	Freeway Volume, V_F	2484		
V_u = veh/h	Ramp Volume, V_R	587	V_D = veh/h	
	Freeway Free-Flow Speed, S_{FF}	60.0		
	Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2484	0.90	Level	9	0	0.957	1.00	2884
Ramp	587	0.90	Level	2	0	0.990	1.00	659
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 2884 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?		Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8		V_F	2884	Exhibit 13-8 4600	No
				$V_{FO} = V_F - V_R$	2225	Exhibit 13-8 4600	No
				V_R	659	Exhibit 13-10 1900	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?		Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8		V_{12}	2884	Exhibit 13-8 4400:All	No

Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 23.7 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = C (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = (Exibit 13-11)	D_s = 0.617 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 48.9 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = N/A mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 48.9 mph (Exhibit 13-13)

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F-3916

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	AJR		Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins		From/To	3025- PaulC WB Off to PaulC On
Date Performed	7/25/2014		Jurisdiction	
Analysis Time Period	AM Peak		Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2439	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	10	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00		E_R	1.2
E_T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.952

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft			
			f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1423   pc/h/ln

S   60.0   mph

D = v_p / S   23.7   pc/mi/ln

LOS   C

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3917

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3025- PaulC WB Off to PaulC On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1897	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	9	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.957

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1101   pc/h/ln

S	60.0	mph
D = v_p / S	18.4	pc/mi/ln
LOS	C	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3918

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3030-EB On from Paul Cantrell
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	850
Deceleration Lane Length L_D	
Freeway Volume, V_F	2439
Ramp Volume, V_R	1662
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2439	0.90	Level	10	0	0.952	1.00	2846
Ramp	1662	0.90	Level	19	0	0.913	1.00	2022
UpStream								
DownStream								

Merge Areas	**Diverge Areas**
Estimation of v_{12}	*Estimation of v_{12}*

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 2846 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	4868	Exhibit 13-8	Yes

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4868	Exhibit 13-8	4600:All	Yes

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   37.2 (pc/mi/ln)

LOS =   F (Exhibit 13-2)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination

M_S =   0.752 (Exibit 13-11)

S_R =   46.5 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   46.5 mph (Exhibit 13-13)

Speed Determination

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-3919

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3030-EB On from Paul Cantrell
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	850
Deceleration Lane Length L_D	
Freeway Volume, V_F	1897
Ramp Volume, V_R	1457
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1897	0.90	Level	9	0	0.957	1.00	2203
Ramp	1457	0.90	Level	18	0	0.917	1.00	1765
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   2203   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3968	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3968	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   30.3 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.451 (Exibit 13-11)

S_R =   51.9 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   51.9 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-3920

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3040 - Paul Cantrell to Leeds*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*4101*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*10*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   *2392*   pc/h/ln

S	*48.6*	mph
D = v_p / S	*49.2*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3921

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3040 - Paul Cantrell to Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description	Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3354	veh/h	Peak-Hour Factor, PHF	0.90
AADT		veh/day	%Trucks and Buses, P_T	9
Peak-Hr Prop. of AADT, K			%RVs, P_R	0
Peak-Hr Direction Prop, D			General Terrain:	Level
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	mi

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.957

Speed Inputs / Calc Speed Adj and FFS

Lane Width		ft			
Rt-Side Lat. Clearance		ft			
Number of Lanes, N	2		f_{LW}		mph
Total Ramp Density, TRD		ramps/mi	f_{LC}		mph
FFS (measured)	60.0	mph	TRD Adjustment		mph
Base free-flow Speed, BFFS		mph	FFS	60.0	mph

LOS and Performance Measures / Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1947	pc/h/ln
S	57.8	mph
D = v_p / S	33.7	pc/mi/ln
LOS	D	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3922

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3050-EB Off to Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On
☑ No ☐ Off

$L_{up} =$ ft
$V_u =$ veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	325
Freeway Volume, V_F	4101
Ramp Volume, V_R	667
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On
☑ No ☐ Off

$L_{down} =$ ft
$V_D =$ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4101	0.90	Level	10	0	0.952	1.00	4785
Ramp	667	0.90	Level	8	0	0.962	1.00	771
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

$L_{EQ} =$ (Equation 13-6 or 13-7)
$P_{FM} =$ using Equation (Exhibit 13-6)
$V_{12} =$ pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or $V_{av34} > 2,700$ pc/h? ☐ Yes ☐ No
Is V_3 or $V_{av34} > 1.5 * V_{12}/2$ ☐ Yes ☐ No
If Yes, $V_{12a} =$ pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

$L_{EQ} =$ (Equation 13-12 or 13-13)
$P_{FD} =$ 1.000 using Equation (Exhibit 13-7)
$V_{12} =$ 4785 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or $V_{av34} > 2,700$ pc/h? ☐ Yes ☑ No
Is V_3 or $V_{av34} > 1.5 * V_{12}/2$ ☐ Yes ☑ No
If Yes, $V_{12a} =$ pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	4785	Exhibit 13-8	4600	Yes
$V_{FO} = V_F - V_R$	4014	Exhibit 13-8	4600	No
V_R	771	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	4785	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

$D_R =$ (pc/mi/ln)
LOS = (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

$D_R =$ 42.5 (pc/mi/ln)
LOS = F (Exhibit 13-2)

Speed Determination — Merge

$M_S =$ (Exibit 13-11)
$S_R =$ mph (Exhibit 13-11)
$S_0 =$ mph (Exhibit 13-11)
$S =$ mph (Exhibit 13-13)

Speed Determination — Diverge

$D_S =$ 0.367 (Exhibit 13-12)
$S_R =$ 53.4 mph (Exhibit 13-12)
$S_0 =$ N/A mph (Exhibit 13-12)
$S =$ 53.4 mph (Exhibit 13-13)

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F-3923

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3050-EB Off to Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes	☐ On	Freeway Number of Lanes, N — 2	☐ Yes	☐ On
☑ No	☐ Off	Ramp Number of Lanes, N — 1	☑ No	☐ Off
		Acceleration Lane Length, L_A		
L_{up} = ft		Deceleration Lane Length L_D — 325	L_{down} = ft	
		Freeway Volume, V_F — 3354		
V_u = veh/h		Ramp Volume, V_R — 315	V_D = veh/h	
		Freeway Free-Flow Speed, S_{FF} — 60.0		
		Ramp Free-Flow Speed, S_{FR} — 45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3354	0.90	Level	9	0	0.957	1.00	3894
Ramp	315	0.90	Level	15	0	0.930	1.00	376
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge) | Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3894 pc/h
V_3 or V_{av34} = pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} = 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	3894	Exhibit 13-8 — 4600	No
$V_{FO} = V_F - V_R$	3518	Exhibit 13-8 — 4600	No
V_R	376	Exhibit 13-10 — 2100	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	3894	Exhibit 13-8 — 4400:All	No

Level of Service Determination (if not F) — Merge | Diverge

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 34.8 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = D (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = (Exibit 13-11)	D_S = 0.332 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 54.0 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = N/A mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 54.0 mph (Exhibit 13-13)

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F-3924

BASIC FREEWAY SEGMENTS WORKSHEET

General Information			*Site Information*	
Analyst	AJR		Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins		From/To	3055 - Leeds Off to Leeds On
Date Performed	7/25/2014		Jurisdiction	
Analysis Time Period	AM Peak		Analysis Year	2018 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3434	veh/h	Peak-Hour Factor, PHF	0.90
AADT		veh/day	%Trucks and Buses, P_T	10
Peak-Hr Prop. of AADT, K			%RVs, P_R	0
Peak-Hr Direction Prop, D			General Terrain:	Level
DDHV = AADT x K x D		veh/h	Grade % Length	mi
			Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.952

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures / Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   **2003**   pc/h/ln

S	57.1	mph
D = v_p / S	35.1	pc/mi/ln
LOS	E	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S	mph
D = v_p / S	pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-3925

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3055 - Leeds Off to Leeds On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3039	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	9	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.957

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1764   pc/h/ln

S   59.5   mph

D = v_p / S   29.6   pc/mi/ln

LOS   D

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-3926

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency/Company	Atkins	Weaving Segment Location	3060 - Leeds to Dorchester
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2020ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3132	0.90	9	0	1.5	1.2	0.957	1.00	3637
V_{RF}	224	0.90	9	0	1.5	1.2	0.957	1.00	260
V_{FR}	302	0.90	12	0	1.5	1.2	0.943	1.00	356
V_{RR}	22	0.90	12	0	1.5	1.2	0.943	1.00	26
V_{NW}	3663							V =	4279
V_W	616								
VR	0.144								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	616 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	869 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1272 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2141 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	740

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4279 pc/h	Weaving intensity factor, W	0.237
Weaving segment capacity, c_w	6175 veh/h	Weaving segment speed, S	49.1 mph
Weaving segment v/c ratio	0.663	Average weaving speed, S_W	51.4 mph
Weaving segment density, D	29.1 pc/mi/ln	Average non-weaving speed, S_{NW}	48.7 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	3971 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-3927

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		**Site Information**	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency/Company	Atkins	Weaving Segment Location	3060 - Leeds to Dorchester
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2020ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2679	0.90	7	0	1.5	1.2	0.966	1.00	3081
V_{RF}	784	0.90	7	0	1.5	1.2	0.966	1.00	902
V_{FR}	360	0.90	7	0	1.5	1.2	0.966	1.00	414
V_{RR}	106	0.90	7	0	1.5	1.2	0.966	1.00	122
V_{NW}	3203							V =	4519
V_W	1316								
VR	0.291								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1316 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1569 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1177 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2746 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	647

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4519 pc/h	Weaving intensity factor, W	0.288
Weaving segment capacity, c_w	5899 veh/h	Weaving segment speed, S	45.0 mph
Weaving segment v/c ratio	0.740	Average weaving speed, S_W	49.9 mph
Weaving segment density, D	33.4 pc/mi/ln	Average non-weaving speed, S_{NW}	43.3 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5490 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-3928

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Project Description   Navy Base ICTF

Site Information

Highway/Direction of Travel	I-526 EB
From/To	3065-Dorches Off to Dorches On
Jurisdiction	
Analysis Year	2018 Build - River Center Site

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	3356	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	0.90	
%Trucks and Buses, P_T	9	
%RVs, P_R	0	
General Terrain:	Level	
Grade % Length	mi	
Up/Down %		

Calculate Flow Adjustments

f_p	1.00
E_T	1.5

E_R	1.2
$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.957

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1948	pc/h/ln
S	57.8	mph
D = v_p / S	33.7	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume

S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

HCS 2010™   Version 6.41

Generated: 12/9/2014   8:45 AM

F-3929

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3065-Dorches Off to Dorches On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3463	veh/h	Peak-Hour Factor, PHF	0.90
AADT		veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K			%RVs, P_R	0
Peak-Hr Direction Prop, D			General Terrain:	Level
DDHV = AADT x K x D		veh/h	Grade % Length	mi
			Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = $1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2001	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	57.1	mph	S	mph
D = v_p / S	35.1	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	E		Required Number of Lanes, N	

Glossary

		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service speed	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

F-3930

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency/Company	Atkins	Weaving Segment Location	3070 - Dorchester to Montague
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1515ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2735	0.90	9	0	1.5	1.2	0.957	1.00	3176
V_{RF}	548	0.90	19	0	1.5	1.2	0.913	1.00	667
V_{FR}	621	0.90	10	0	1.5	1.2	0.952	1.00	725
V_{RR}	124	0.90	19	0	1.5	1.2	0.913	1.00	151
V_{NW}	3327							V =	4719
V_W	1392								
VR	0.295								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1392 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1588 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	929 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2517 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	403

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4719 pc/h	Weaving intensity factor, W	0.337
Weaving segment capacity, c_w	5722 veh/h	Weaving segment speed, S	44.1 mph
Weaving segment v/c ratio	0.789	Average weaving speed, S_W	48.6 mph
Weaving segment density, D	35.7 pc/mi/ln	Average non-weaving speed, S_{NW}	42.4 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5530 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-3931

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency/Company	Atkins	Weaving Segment Location	3070 - Dorchester to Montague
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1515ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2667	0.90	8	0	1.5	1.2	0.962	1.00	3082
V_{RF}	780	0.90	11	0	1.5	1.2	0.948	1.00	914
V_{FR}	796	0.90	8	0	1.5	1.2	0.962	1.00	920
V_{RR}	233	0.90	11	0	1.5	1.2	0.948	1.00	273
V_{NW}	3355							V =	5189
V_W	1834								
VR	0.353								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1834 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2030 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	934 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2964 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	407

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5189 pc/h	Weaving intensity factor, W	0.384
Weaving segment capacity, c_w	5608 veh/h	Weaving segment speed, S	41.3 mph
Weaving segment v/c ratio	0.890	Average weaving speed, S_W	47.5 mph
Weaving segment density, D	41.9 pc/mi/ln	Average non-weaving speed, S_{NW}	38.5 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6164 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-3932

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3080-Montague to International*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3283*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*9*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)		

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) *1906* pc/h/ln

S	*58.3*	mph
D = v_p / S	*32.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) pc/h/ln

S		mph
D = v_p / S		pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3933

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3080-Montague to International
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3447	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	9	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.957

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2001	pc/h/ln	Design LOS		
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	57.1	mph	S		mph
D = v_p / S	35.1	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	E		Required Number of Lanes, N		

Glossary

		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service speed	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3934

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3090-EB Off to InternationalWB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A		
Deceleration Lane Length L_D	700	
Freeway Volume, V_F	3283	
Ramp Volume, V_R	629	
Freeway Free-Flow Speed, S_{FF}	60.0	
Ramp Free-Flow Speed, S_{FR}	25.0	

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3283	0.90	Level	9	0	0.957	1.00	3812
Ramp	629	0.90	Level	8	0	0.962	1.00	727
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   3812 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	3812	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3085	Exhibit 13-8	4600	No
V_R	727	Exhibit 13-10	1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3812	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   30.7 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.623 (Exhibit 13-12)

S_R =   48.8 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   48.8 mph (Exhibit 13-13)

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F-3935

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information — Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3090-EB Off to InternationalWB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	3447
Ramp Volume, V_R	646
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3447	0.90	Level	9	0	0.957	1.00	4002
Ramp	646	0.90	Level	7	0	0.966	1.00	743
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) — Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} = pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4002 pc/h

V_3 or V_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge:

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Diverge:

	Actual	Capacity	LOS F?
V_F	4002	Exhibit 13-8 4600	No
$V_{FO} = V_F - V_R$	3259	Exhibit 13-8 4600	No
V_R	743	Exhibit 13-10 1900	No

Flow Entering Merge Influence Area — Flow Entering Diverge Influence Area

Merge:

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Diverge:

	Actual	Max Desirable	Violation?
V_{12}	4002	Exhibit 13-8 4400:All	No

Level of Service Determination (if not F)

Merge:

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Diverge:

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = 32.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

Merge:

M_S = (Exibit 13-11)

S_R = mph (Exhibit 13-11)

S_0 = mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge:

D_S = 0.625 (Exhibit 13-12)

S_R = 48.8 mph (Exhibit 13-12)

S_0 = N/A mph (Exhibit 13-12)

S = 48.8 mph (Exhibit 13-13)

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F-3936

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3095- Inter WB Off to Inter On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*2654*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*10*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures / Design (N)

Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1548*	pc/h/ln	Design LOS		
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*60.0*	mph	S		mph
D = v_p / S	*25.8*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*C*		Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   8:50 AM

F-3937

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3095- Inter WB Off to Inter On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2801	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	9	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.957

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1626	pc/h/ln
S	60.0	mph
D = v_p / S	27.1	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes   S   - Speed
V - Hourly volume   D   - Density
v_p - Flow rate   FFS - Free-flow speed
LOS   - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-3938

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		**Site Information**	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency/Company	Atkins	Weaving Segment Location	3100 - International to I-26
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2025ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1233	0.90	10	0	1.5	1.2	0.952	1.00	1439
V_{RF}	589	0.90	10	0	1.5	1.2	0.952	1.00	687
V_{FR}	1421	0.90	11	0	1.5	1.2	0.948	1.00	1666
V_{RR}	678	0.90	11	0	1.5	1.2	0.948	1.00	795
V_{NW}	2234							V =	4587
V_W	2353								
VR	0.513								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	687 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	941 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	980 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	1921 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	452

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4587 pc/h	Weaving intensity factor, W	0.217
Weaving segment capacity, c_w	5469 veh/h	Weaving segment speed, S	45.2 mph
Weaving segment v/c ratio	0.799	Average weaving speed, S_W	47.9 mph
Weaving segment density, D	33.8 pc/mi/ln	Average non-weaving speed, S_{NW}	42.7 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	6412 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-3939

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency/Company	Atkins	Weaving Segment Location	3100 - International to I-26
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2025ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1352	0.90	9	0	1.5	1.2	0.957	1.00	1570
V_{RF}	911	0.90	9	0	1.5	1.2	0.957	1.00	1058
V_{FR}	1449	0.90	9	0	1.5	1.2	0.957	1.00	1682
V_{RR}	977	0.90	9	0	1.5	1.2	0.957	1.00	1134
V_{NW}	2704							V =	5444
V_W	2740								
VR	0.503								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	1058 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1312 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1077 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	2389 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	548

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5444 pc/h	Weaving intensity factor, W	0.257
Weaving segment capacity, c_w	5521 veh/h	Weaving segment speed, S	42.4 mph
Weaving segment v/c ratio	0.944	Average weaving speed, S_W	46.8 mph
Weaving segment density, D	42.8 pc/mi/ln	Average non-weaving speed, S_{NW}	38.7 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6299 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   8:52 AM

F-3940

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	I-526 EB
From/To	3105-I-26 Off to I-26 EB CD On
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1822	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	17	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.922

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1098	pc/h/ln
S	55.0	mph
D = v_p / S	20.0	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3941

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3105-I-26 Off to I-26 EB CD On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2263	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	15	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.930

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
			Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1352	pc/h/ln	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	55.0	mph	S		mph
D = v_p / S	24.6	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	C		Required Number of Lanes, N		

Glossary / Factor Location

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service speed	BFFS - Base free-flow	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3942

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3110-EB On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp	Freeway Number of Lanes, N	2	Downstream Adj Ramp
☐ Yes ☐ On	Ramp Number of Lanes, N	1	☐ Yes ☐ On
	Acceleration Lane Length, L_A	625	
☑ No ☐ Off	Deceleration Lane Length L_D		☑ No ☐ Off
	Freeway Volume, V_F	1822	
L_{up} = ft	Ramp Volume, V_R	1365	L_{down} = ft
	Freeway Free-Flow Speed, S_{FF}	55.0	
V_u = veh/h	Ramp Free-Flow Speed, S_{FR}	25.0	V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1822	0.90	Level	17	0	0.922	1.00	2197
Ramp	1365	0.90	Level	53	0	0.791	1.00	1919
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge) | Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 2197 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No	Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	4116	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4116	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 32.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination — Merge

M_S = 0.529 (Exibit 13-11)

S_R = 48.1 mph (Exhibit 13-11)

S_0 = N/A mph (Exhibit 13-11)

S = 48.1 mph (Exhibit 13-13)

Speed Determination — Diverge

D_s = (Exhibit 13-12)

S_R = mph (Exhibit 13-12)

S_0 = mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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F-3943

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3110-EB On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	625
Deceleration Lane Length L_D	
Freeway Volume, V_F	2263
Ramp Volume, V_R	1116
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2263	0.90	Level	15	0	0.930	1.00	2703
Ramp	1116	0.90	Level	55	0	0.784	1.00	1581
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   2703   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	4284	Exhibit 13-8	No

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4284	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   34.2 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination

M_S =   0.573 (Exibit 13-11)

S_R =   47.6 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   47.6 mph (Exhibit 13-13)

Speed Determination

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-3944

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency/Company	Atkins	Weaving Segment Location	3120 - I-26 WB to Rivers Ave
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1615ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2981	0.90	17	0	1.5	1.2	0.922	1.00	3594
V_{RF}	467	0.90	17	0	1.5	1.2	0.922	1.00	563
V_{FR}	206	0.90	19	0	1.5	1.2	0.913	1.00	251
V_{RR}	32	0.90	19	0	1.5	1.2	0.913	1.00	39
V_{NW}	3633							V =	4447
V_W	814								
VR	0.183								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	814 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1053 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1046 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2099 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	704

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4447 pc/h	Weaving intensity factor, W	0.278
Weaving segment capacity, c_w	5641 veh/h	Weaving segment speed, S	42.7 mph
Weaving segment v/c ratio	0.727	Average weaving speed, S_W	46.3 mph
Weaving segment density, D	34.7 pc/mi/ln	Average non-weaving speed, S_{NW}	42.0 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4364 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-3945

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	

General Information			Site Information	
Analyst	AJR		Freeway/Dir of Travel	I-526 EB
Agency/Company	Atkins		Weaving Segment Location	3120 - I-26 WB to Rivers Ave
Date Performed	7/25/2014		Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak			

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1615ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3047	0.90	15	0	1.5	1.2	0.930	1.00	3639
V_{RF}	405	0.90	15	0	1.5	1.2	0.930	1.00	484
V_{FR}	332	0.90	15	0	1.5	1.2	0.930	1.00	397
V_{RR}	44	0.90	10	0	1.5	1.2	0.952	1.00	51
V_{NW}	3690							V =	4571
V_W	881								
VR	0.193								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	881 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1120 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1058 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2178 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	715

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4571 pc/h	Weaving intensity factor, W	0.286
Weaving segment capacity, c_w	5671 veh/h	Weaving segment speed, S	42.2 mph
Weaving segment v/c ratio	0.750	Average weaving speed, S_W	46.1 mph
Weaving segment density, D	36.1 pc/mi/ln	Average non-weaving speed, S_{NW}	41.3 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	4462 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-3946

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3130-EB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp					Downstream Adj Ramp	
☐ Yes	☐ On	Freeway Number of Lanes, N	2		☐ Yes	☐ On
☑ No	☐ Off	Ramp Number of Lanes, N	1		☑ No	☐ Off
		Acceleration Lane Length, L_A				
L_{up} = ft		Deceleration Lane Length L_D	800		L_{down} = ft	
		Freeway Volume, V_F	3448			
V_u = veh/h		Ramp Volume, V_R	161		V_D = veh/h	
		Freeway Free-Flow Speed, S_{FF}	55.0			
		Ramp Free-Flow Speed, S_{FR}	25.0			

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3448	0.90	Level	17	0	0.922	1.00	4157
Ramp	161	0.90	Level	23	0	0.897	1.00	199
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 4157 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge:

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Diverge:

	Actual	Capacity	LOS F?
V_F	4157	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3958	Exhibit 13-8	4500	No
V_R	199	Exhibit 13-10	1900	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Merge:

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Diverge:

	Actual	Max Desirable	Violation?
V_{12}	4157	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge:

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Diverge:

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = 32.8 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination

Merge:

M_S =   (Exibit 13-11)
S_R = mph (Exhibit 13-11)
S_0 = mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge:

D_S = 0.576 (Exhibit 13-12)
S_R = 47.5 mph (Exhibit 13-12)
S_0 = N/A mph (Exhibit 13-12)
S = 47.5 mph (Exhibit 13-13)

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F-3947

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3130-EB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	800
Freeway Volume, V_F	3452
Ramp Volume, V_R	343
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3452	0.90	Level	15	0	0.930	1.00	4123
Ramp	343	0.90	Level	9	0	0.957	1.00	398
UpStream								
DownStream								

Merge Areas — Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas — Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   4123 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	4123	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3725	Exhibit 13-8	4500	No
V_R	398	Exhibit 13-10	1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	4123	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   32.5 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination — Merge

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination — Diverge

D_S =   0.594 (Exhibit 13-12)

S_R =   47.3 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   47.3 mph (Exhibit 13-13)

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F-3948

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3135-RiversNB Off to Rivers On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3287	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	17	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T-1)+P_R(E_R-1)]$	0.922

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures / Design (N)

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ 1981   pc/h/ln

S   54.2   mph

$D = v_p / S$ 36.6   pc/mi/ln

LOS   E

Design (N)
Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S   mph

$D = v_p / S$ pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

F-3949

BASIC FREEWAY SEGMENTS WORKSHEET

General Information			*Site Information*	
Analyst	*AJR*		Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*		From/To	*3135-RiversNB Off to Rivers On*
Date Performed	*7/25/2014*		Jurisdiction	
Analysis Time Period	*PM Peak*		Analysis Year	*2018 Build - River Center Site*

Project Description	*Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3109*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*15*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) ... *1857* pc/h/ln

S	*54.9*	mph
D = v_p / S	*33.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) ... pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3950

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3140-EB On from Rivers
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A	825	
Deceleration Lane Length L_D		
Freeway Volume, V_F	3287	
Ramp Volume, V_R	476	
Freeway Free-Flow Speed, S_{FF}	55.0	
Ramp Free-Flow Speed, S_{FR}	45.0	

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3287	0.90	Level	17	0	0.922	1.00	3963
Ramp	476	0.90	Level	2	0	0.990	1.00	534
UpStream								
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 3963 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks				**Capacity Checks**			
	Actual	Capacity	LOS F?		Actual	Capacity	LOS F?
				V_F		Exhibit 13-8	
V_{FO}	4497	Exhibit 13-8	No	$V_{FO} = V_F - V_R$		Exhibit 13-8	
				V_R		Exhibit 13-10	

Flow Entering Merge Influence Area				**Flow Entering Diverge Influence Area**			
	Actual	Max Desirable	Violation?		Actual	Max Desirable	Violation?
V_{R12}	4497	Exhibit 13-8 4600:All	No	V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)	**Level of Service Determination (if not F)**
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = 35.1 (pc/mi/ln)	D_R = (pc/mi/ln)
LOS = E (Exhibit 13-2)	LOS = (Exhibit 13-2)

Speed Determination	**Speed Determination**
M_S = 0.597 (Exibit 13-11)	D_s = (Exhibit 13-12)
S_R = 47.2 mph (Exhibit 13-11)	S_R = mph (Exhibit 13-12)
S_0 = N/A mph (Exhibit 13-11)	S_0 = mph (Exhibit 13-12)
S = 47.2 mph (Exhibit 13-13)	S = mph (Exhibit 13-13)

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F-3951

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3140-EB On from Rivers
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	825
Deceleration Lane Length L_D	
Freeway Volume, V_F	3109
Ramp Volume, V_R	460
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3109	0.90	Level	15	0	0.930	1.00	3714
Ramp	460	0.90	Level	2	0	0.990	1.00	516
UpStream								
DownStream								

Merge Areas	**Diverge Areas**
Estimation of v_{12}	*Estimation of v_{12}*

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 3714 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No	Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks	*Capacity Checks*

	Actual	Capacity	LOS F?
V_{FO}	4230	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area	*Flow Entering Diverge Influence Area*

	Actual	Max Desirable		Violation?
V_{R12}	4230	Exhibit 13-8	4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)	*Level of Service Determination (if not F)*
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = 33.1 (pc/mi/ln)	D_R = (pc/mi/ln)
LOS = D (Exhibit 13-2)	LOS = (Exhibit 13-2)

Speed Determination	*Speed Determination*
M_S = 0.515 (Exibit 13-11)	D_s = (Exhibit 13-12)
S_R = 48.3 mph (Exhibit 13-11)	S_R = mph (Exhibit 13-12)
S_0 = N/A mph (Exhibit 13-11)	S_0 = mph (Exhibit 13-12)
S = 48.3 mph (Exhibit 13-13)	S = mph (Exhibit 13-13)

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F-3952

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*
Agency or Company	*Atkins*
Date Performed	*7/25/2014*
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-526 EB*
From/To	*3150-Rivers to Rhett*
Jurisdiction	
Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*3763*	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	*0.90*	
%Trucks and Buses, P_T	*15*	
%RVs, P_R	*0*	
General Terrain:	*Level*	
Grade % Length	*mi*	
Up/Down %		

Calculate Flow Adjustments

f_p *1.00*	E_R *1.2*
E_T *1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ *0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

v_p	*2247*	pc/h/ln
S	*52.4*	mph
D = v_p / S	*42.9*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3953

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*
Agency or Company	*Atkins*
Date Performed	*7/25/2014*
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-526 EB*
From/To	*3150-Rivers to Rhett*
Jurisdiction	
Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*3569*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*14*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.935*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2122*	pc/h/ln
S	*55.1*	mph
D = v_p / S	*38.5*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3954

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3160-EB Off to Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description　　Navy Base ICTF			

Inputs

Upstream Adj Ramp

☐ Yes　　☐ On

☑ No　　☐ Off

L_{up} = 　　ft

V_u = 　　veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	225
Freeway Volume, V_F	3763
Ramp Volume, V_R	483
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes　　☐ On

☑ No　　☐ Off

L_{down} = 　　ft

V_D = 　　veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3763	0.90	Level	15	0	0.930	1.00	4495
Ramp	483	0.90	Level	7	0	0.966	1.00	555
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12}	*Estimation of v_{12}*
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = 　　(Equation 13-6 or 13-7)	L_{EQ} = 　　(Equation 13-12 or 13-13)
P_{FM} = 　　using Equation (Exhibit 13-6)	P_{FD} = 　1.000　using Equation (Exhibit 13-7)
V_{12} = 　　pc/h	V_{12} = 　4495　pc/h
V_3 or V_{av34} 　　pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 　　0　pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No	Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No
If Yes,V_{12a} = 　　pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = 　　pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks

	Actual	Capacity	LOS F?
V_F	4495	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3940	Exhibit 13-8	4600	No
V_R	555	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	4495	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = 　　(pc/mi/ln)

LOS = 　　(Exhibit 13-2)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = 　40.9　(pc/mi/ln)

LOS = 　E (Exhibit 13-2)

Speed Determination

M_S = 　　(Exibit 13-11)

S_R = 　　mph (Exhibit 13-11)

S_0 = 　　mph (Exhibit 13-11)

S = 　　mph (Exhibit 13-13)

Speed Determination

D_s = 　0.348 (Exhibit 13-12)

S_R = 　53.7 mph (Exhibit 13-12)

S_0 = 　N/A mph (Exhibit 13-12)

S = 　53.7 mph (Exhibit 13-13)

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F-3955

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3160-EB Off to Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	225
Freeway Volume, V_F	3569
Ramp Volume, V_R	703
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3569	0.90	Level	14	0	0.935	1.00	4243
Ramp	703	0.90	Level	4	0	0.980	1.00	797
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} = pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4243 pc/h

V_3 or V_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	4243	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3446	Exhibit 13-8	4600	No
V_R	797	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	4243	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = 38.7 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination (Merge)

M_S = (Exibit 13-11)

S_R = mph (Exhibit 13-11)

S_0 = mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S = 0.370 (Exhibit 13-12)

S_R = 53.3 mph (Exhibit 13-12)

S_0 = N/A mph (Exhibit 13-12)

S = 53.3 mph (Exhibit 13-13)

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F-3956

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3165 - Rhett Off to Rhett On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3280	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*15*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   *1959*   pc/h/ln

S	*57.7*	mph
D = v_p / S	*34.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

F-3957

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3165 - Rhett Off to Rhett On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2866	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	14	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length mi		
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ 0.935	

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1704   pc/h/ln

S   59.8   mph

D = v_p / S   28.5   pc/mi/ln

LOS   D

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3958

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency/Company	Atkins	Weaving Segment Location	3170 - Rhett to Virginia
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1090ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2815	0.90	14	0	1.5	1.2	0.935	1.00	3347
V_{RF}	1135	0.90	14	0	1.5	1.2	0.935	1.00	1349
V_{FR}	465	0.90	14	0	1.5	1.2	0.935	1.00	553
V_{RR}	188	0.90	11	0	1.5	1.2	0.948	1.00	220
V_{NW}	3567							V =	5469
V_W	1902								
VR	0.348								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1902 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	2053 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	748 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2801 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	272

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5469 pc/h	Weaving intensity factor, W	0.476
Weaving segment capacity, c_w	5375 veh/h	Weaving segment speed, S	40.0 mph
Weaving segment v/c ratio	0.951	Average weaving speed, S_W	45.5 mph
Weaving segment density, D	45.6 pc/mi/ln	Average non-weaving speed, S_{NW}	37.6 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6102 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-3959

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency/Company	Atkins	Weaving Segment Location	3170 - Rhett to Virginia
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1090ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2730	0.90	13	0	1.5	1.2	0.939	1.00	3231
V_{RF}	977	0.90	13	0	1.5	1.2	0.939	1.00	1156
V_{FR}	136	0.90	33	0	1.5	1.2	0.858	1.00	176
V_{RR}	49	0.90	33	0	1.5	1.2	0.858	1.00	63
V_{NW}	3294							V =	4626
V_W	1332								
VR	0.288								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1332 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	1483 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	692 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2175 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	251

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4626 pc/h	Weaving intensity factor, W	0.390
Weaving segment capacity, c_w	5538 veh/h	Weaving segment speed, S	44.2 mph
Weaving segment v/c ratio	0.784	Average weaving speed, S_W	47.4 mph
Weaving segment density, D	34.9 pc/mi/ln	Average non-weaving speed, S_{NW}	43.0 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5455 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-3960

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3180-Virginia to ClementsFerry*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description	*Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*3950*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*12*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	2326	pc/h/ln
S	*50.4*	mph
D = v_p / S	*46.1*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3961

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3180-Virginia to ClementsFerry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3707	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	12	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.943

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   2183   pc/h/ln

S	53.8	mph
D = v_p / S	40.6	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3962

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3190-EB Off to ClementsFerrySB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	250
Freeway Volume, V_F	3950
Ramp Volume, V_R	366
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3950	0.90	Level	12	0	0.943	1.00	4652
Ramp	366	0.90	Level	8	0	0.962	1.00	423
UpStream								
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   4652 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	4652	Exhibit 13-8 4600	Yes
$V_{FO} = V_F - V_R$	4229	Exhibit 13-8 4600	No
V_R	423	Exhibit 13-10 2100	No

Flow Entering Merge Influence Area / Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	4652	Exhibit 13-8 4400:All	Yes

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   42.0 (pc/mi/ln)

LOS =   F (Exhibit 13-2)

Speed Determination

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

D_s =   0.336 (Exhibit 13-12)

S_R =   54.0 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   54.0 mph (Exhibit 13-13)

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F-3963

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3190-EB Off to ClementsFerrySB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description	Navy Base ICTF

Inputs

Upstream Adj Ramp				Downstream Adj Ramp	
☐ Yes	☐ On	Freeway Number of Lanes, N	2	☐ Yes	☐ On
		Ramp Number of Lanes, N	1		
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
		Deceleration Lane Length L_D	250		
L_{up} = ft		Freeway Volume, V_F	3707	L_{down} = ft	
		Ramp Volume, V_R	190		
V_u = veh/h		Freeway Free-Flow Speed, S_{FF}	60.0	V_D = veh/h	
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3707	0.90	Level	12	0	0.943	1.00	4366
Ramp	190	0.90	Level	13	0	0.939	1.00	225
UpStream								
DownStream								

Merge Areas	**Diverge Areas**
Estimation of v_{12}	*Estimation of v_{12}*

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 4366 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?		Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8		V_F	4366	Exhibit 13-8	4600	No
				$V_{FO} = V_F - V_R$	4141	Exhibit 13-8	4600	No
				V_R	225	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?		Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8		V_{12}	4366	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 39.5 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = E (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = (Exibit 13-11)	D_S = 0.318 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 54.3 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = N/A mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 54.3 mph (Exhibit 13-13)

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F-3964

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information   Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3200-EB Off to ClementsFerryNB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	900
Freeway Volume, V_F	3584
Ramp Volume, V_R	872
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3584	0.90	Level	12	0	0.943	1.00	4221
Ramp	872	0.90	Level	21	0	0.905	1.00	1071
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | ### Estimation of v_{12} (Diverge)

Merge Areas — Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas — Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   4221 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	4221	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3150	Exhibit 13-8	4600	No
V_R	1071	Exhibit 13-10	1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	4221	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   32.5 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination — Merge

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination — Diverge

D_s =   0.654 (Exhibit 13-12)

S_R =   48.2 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   48.2 mph (Exhibit 13-13)

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F-3965

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3200-EB Off to ClementsFerryNB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description	Navy Base ICTF

Inputs

Upstream Adj Ramp			Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N	2	☐ Yes ☐ On
	Ramp Number of Lanes, N	1	
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
	Deceleration Lane Length L_D	900	
L_{up} = ft	Freeway Volume, V_F	3517	L_{down} = ft
	Ramp Volume, V_R	800	
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D = veh/h
	Ramp Free-Flow Speed, S_{FR}	25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3517	0.90	Level	12	0	0.943	1.00	4142
Ramp	800	0.90	Level	20	0	0.909	1.00	978
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   4142 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	4142	Exhibit 13-8 4600	No
$V_{FO} = V_F - V_R$	3164	Exhibit 13-8 4600	No
V_R	978	Exhibit 13-10 1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	4142	Exhibit 13-8 4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   31.8 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.646 (Exhibit 13-12)

S_R =   48.4 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   48.4 mph (Exhibit 13-13)

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F-3966

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	AJR		Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins		From/To	3205-ClemFerry NB Off to NB On
Date Performed	7/25/2014		Jurisdiction	
Analysis Time Period	AM Peak		Analysis Year	2018 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2712	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	12	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.943

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1597   pc/h/ln

S	60.0	mph
D = v_p / S	26.6	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S   - Speed
V - Hourly volume   D   - Density
v_p - Flow rate   FFS - Free-flow speed
LOS   - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-3967

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR			
Agency or Company	Atkins			
Date Performed	7/25/2014			
Analysis Time Period	PM Peak			

Site Information

Highway/Direction of Travel	I-526 EB
From/To	3205-ClemFerry NB Off to NB On
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2717	veh/h	Peak-Hour Factor, PHF	0.90
AADT		veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K			%RVs, P_R	0
Peak-Hr Direction Prop, D			General Terrain:	Level
DDHV = AADT x K x D		veh/h	Grade % Length	mi
			Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.943

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1600	pc/h/ln
S	60.0	mph
D = v_p / S	26.7	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3968

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3210-EB On from Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	2	☐ Yes ☐ On	
	Ramp Number of Lanes, N	1		
☑ No ☐ Off	Acceleration Lane Length, L_A	1025	☑ No ☐ Off	
	Deceleration Lane Length L_D			
L_{up} = ft	Freeway Volume, V_F	2712	L_{down} = ft	
	Ramp Volume, V_R	380		
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D = veh/h	
	Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2712	0.90	Level	12	0	0.943	1.00	3194
Ramp	380	0.90	Level	9	0	0.957	1.00	441
UpStream								
DownStream								

Merge Areas	**Diverge Areas**
Estimation of v_{12}	**Estimation of v_{12}**

Merge Areas — Estimation of v_{12}	Diverge Areas — Estimation of v_{12}
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 3194 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	3635	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3635	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   27.2 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination

M_S =   0.377 (Exibit 13-11)

S_R =   53.2 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   53.2 mph (Exhibit 13-13)

Speed Determination

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-3969

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3210-EB On from Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	2	☐ Yes ☐ On	
	Ramp Number of Lanes, N	1		
☑ No ☐ Off	Acceleration Lane Length, L_A	1025	☑ No ☐ Off	
	Deceleration Lane Length L_D			
L_{up} = ft	Freeway Volume, V_F	2717	L_{down} = ft	
	Ramp Volume, V_R	582		
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D = veh/h	
	Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2717	0.90	Level	12	0	0.943	1.00	3200
Ramp	582	0.90	Level	5	0	0.976	1.00	663
UpStream								
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12} (Merge Areas)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   1.000   using Equation (Exhibit 13-6)
V_{12} =   3200   pc/h
V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge Areas)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   using Equation (Exhibit 13-7)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge:

	Actual	Capacity	LOS F?
V_{FO}	3863	Exhibit 13-8	No

Diverge:

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Merge:

	Actual	Max Desirable		Violation?
V_{R12}	3863	Exhibit 13-8	4600:All	No

Diverge:

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge:

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   28.9 (pc/mi/ln)
LOS =   D (Exhibit 13-2)

Diverge:

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Speed Determination

Merge:

M_S =   0.414 (Exibit 13-11)
S_R =   52.5 mph (Exhibit 13-11)
S_0 =   N/A mph (Exhibit 13-11)
S =   52.5 mph (Exhibit 13-13)

Diverge:

D_s =   (Exhibit 13-12)
S_R =   mph (Exhibit 13-12)
S_0 =   mph (Exhibit 13-12)
S =   mph (Exhibit 13-13)

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F-3970

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3220-ClementsFerrytoRiversLand
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3092	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	10	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.952

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1804   pc/h/ln

S	59.2	mph
D = v_p / S	30.5	pc/mi/ln
LOS	D	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3971

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3220-ClementsFerrytoRiversLand*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*3299*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*9*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs | ### Calc Speed Adj and FFS

Speed Inputs				Calc Speed Adj and FFS		
Lane Width		ft				
Rt-Side Lat. Clearance		ft		f_{LW}		mph
Number of Lanes, N	*2*			f_{LC}		mph
Total Ramp Density, TRD		ramps/mi		TRD Adjustment		mph
FFS (measured)	*60.0*	mph		FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph				

LOS and Performance Measures | ### Design (N)

LOS and Performance Measures				Design (N)		
Operational (LOS)				Design (N)		
				Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1915*	pc/h/ln		v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*58.2*	mph		S		mph
D = v_p / S	*32.9*	pc/mi/ln		D = v_p / S		pc/mi/ln
LOS	*D*			Required Number of Lanes, N		

Glossary | ### Factor Location

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service speed	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3972

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3230-EB Off to River Landing
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	800
Freeway Volume, V_F	3092
Ramp Volume, V_R	766
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3092	0.90	Level	10	0	0.952	1.00	3607
Ramp	766	0.90	Level	3	0	0.985	1.00	864
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   3607 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	3607	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2743	Exhibit 13-8	4700	No
V_R	864	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3607	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   28.1 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.376 (Exhibit 13-12)

S_R =   56.4 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   56.4 mph (Exhibit 13-13)

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F-3973

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3230-EB Off to River Landing
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	800
Freeway Volume, V_F	3299
Ramp Volume, V_R	792
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3299	0.90	Level	9	0	0.957	1.00	3831
Ramp	792	0.90	Level	3	0	0.985	1.00	893
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   3831 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge:

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Diverge:

	Actual	Capacity	LOS F?
V_F	3831	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2938	Exhibit 13-8	4700	No
V_R	893	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Merge:

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Diverge:

	Actual	Max Desirable	Violation?
V_{12}	3831	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge:

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Diverge:

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   30.0 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination

Merge:

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Diverge:

D_S =   0.378 (Exhibit 13-12)

S_R =   56.3 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   56.3 mph (Exhibit 13-13)

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F-3974

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3235-RiverLa Off to RiverLa On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2326	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	11	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1363	pc/h/ln
S	65.0	mph
D = v_p / S	21.0	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3975

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3235-RiverLa Off to RiverLa On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2507	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	11	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1469   pc/h/ln

S   64.9   mph

D = v_p / S   22.6   pc/mi/ln

LOS   C

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3976

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3240-EB On from River Landing
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	1400
Deceleration Lane Length L_D	
Freeway Volume, V_F	2326
Ramp Volume, V_R	620
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2326	0.90	Level	11	0	0.948	1.00	2727
Ramp	620	0.90	Level	10	0	0.952	1.00	723
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   2727   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3450	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3450	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   23.3 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.374 (Exibit 13-11)

S_R =   56.4 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   56.4 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-3977

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3240-EB On from River Landing
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	1400
Deceleration Lane Length L_D	
Freeway Volume, V_F	2507
Ramp Volume, V_R	510
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2507	0.90	Level	11	0	0.948	1.00	2939
Ramp	510	0.90	Level	10	0	0.952	1.00	595
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   2939   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3534	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3534	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   24.0 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.385 (Exibit 13-11)

S_R =   56.2 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   56.2 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-3978

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	*AJR*		Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*		From/To	*3250-RiverLanding to LongPoint*
Date Performed	*7/25/2014*		Jurisdiction	
Analysis Time Period	*AM Peak*		Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*2946*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*11*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) *1727* pc/h/ln

S   *63.5* mph

D = v_p / S   *27.2* pc/mi/ln

LOS   *D*

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed

V - Hourly volume   D - Density

v_p - Flow rate   FFS - Free-flow speed

LOS - Level of service   BFFS - Base free-flow speed

DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8

E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9

f_p - Page 11-18   TRD - Page 11-11

LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-3979

BASIC FREEWAY SEGMENTS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3250-RiverLanding to LongPoint
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3017	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	11	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs | Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures | Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1768   pc/h/ln

S	63.1	mph
D = v_p / S	28.0	pc/mi/ln
LOS	D	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary | Factor Location

Glossary		
N - Number of lanes	S - Speed	
V - Hourly volume	D - Density	
v_p - Flow rate	FFS - Free-flow speed	
LOS - Level of service speed	BFFS - Base free-flow speed	
DDHV - Directional design hour volume		

Factor Location		
E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8	
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9	
f_p - Page 11-18	TRD - Page 11-11	
LOS, S, FFS, v_p - Exhibits 11-2, 11-3		

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F-3980

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information　　　　　　　Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3260-EB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes	☐ On	Freeway Number of Lanes, N　　2	☐ Yes	☐ On
		Ramp Number of Lanes, N　　1		
☑ No	☐ Off	Acceleration Lane Length, L_A	☑ No	☐ Off
		Deceleration Lane Length L_D　　225		
$L_{up} =$　　ft		Freeway Volume, V_F　　2946	$L_{down} =$　　ft	
		Ramp Volume, V_R　　1089		
$V_u =$　　veh/h		Freeway Free-Flow Speed, S_{FF}　　65.0	$V_D =$　　veh/h	
		Ramp Free-Flow Speed, S_{FR}　　45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2946	0.90	Level	11	0	0.948	1.00	3453
Ramp	1089	0.90	Level	23	0	0.897	1.00	1349
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} （Merge）

$$V_{12} = V_F (P_{FM})$$

$L_{EQ} =$　　(Equation 13-6 or 13-7)

$P_{FM} =$　　using Equation (Exhibit 13-6)

$V_{12} =$　　pc/h

V_3 or V_{av34}　　pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, $V_{12a} =$　　pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} （Diverge）

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

$L_{EQ} =$　　(Equation 13-12 or 13-13)

$P_{FD} =$　　1.000　using Equation (Exhibit 13-7)

$V_{12} =$　　3453　pc/h

V_3 or V_{av34}　　0　pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, $V_{12a} =$　　pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks （Merge）

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks （Diverge）

	Actual	Capacity	LOS F?
V_F	3453	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2104	Exhibit 13-8　4700	No
V_R	1349	Exhibit 13-10　2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	3453	Exhibit 13-8　4400:All	No

Level of Service Determination (if not F) （Merge）

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

$D_R =$　　(pc/mi/ln)

LOS =　　(Exhibit 13-2)

Level of Service Determination (if not F) （Diverge）

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

$D_R =$　　31.9　(pc/mi/ln)

LOS =　　D (Exhibit 13-2)

Speed Determination （Merge）

$M_S =$　　(Exibit 13-11)

$S_R =$　　mph (Exhibit 13-11)

$S_0 =$　　mph (Exhibit 13-11)

$S =$　　mph (Exhibit 13-13)

Speed Determination （Diverge）

$D_S =$　　0.419 (Exhibit 13-12)

$S_R =$　　55.4 mph (Exhibit 13-12)

$S_0 =$　　N/A mph (Exhibit 13-12)

$S =$　　55.4 mph (Exhibit 13-13)

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F-3981

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information   Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3260-EB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2		Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1		☐ Yes	☐ On
		Acceleration Lane Length, L_A				
☑ No	☐ Off	Deceleration Lane Length L_D	225		☑ No	☐ Off
		Freeway Volume, V_F	3017			
L_{up} =	ft	Ramp Volume, V_R	1167		L_{down} =	ft
		Freeway Free-Flow Speed, S_{FF}	65.0			
V_u =	veh/h	Ramp Free-Flow Speed, S_{FR}	45.0		V_D =	veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3017	0.90	Level	11	0	0.948	1.00	3537
Ramp	1167	0.90	Level	19	0	0.913	1.00	1420
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3537 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	3537	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2117	Exhibit 13-8	4700	No
V_R	1420	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	3537	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) — Merge

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   32.6 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination — Merge

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination — Diverge

D_S =   0.426 (Exhibit 13-12)

S_R =   55.2 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   55.2 mph (Exhibit 13-13)

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F-3982

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3265-LongPt Off to LongPtWB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*1857*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*11*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs | ### Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures | ### Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   *1088*   pc/h/ln

S	*65.0*	mph
D = v_p / S	*16.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln

Required Number of Lanes, N

Glossary | ### Factor Location

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service speed	BFFS - Base free-flow	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3983

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3265-LongPt Off to LongPtWB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*1850*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*11*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

$v_p = (V$ or $DDHV) / (PHF$ x N x f_{HV} x $f_p)$ *1084*   pc/h/ln

S	*65.0*	mph
D = v_p / S	*16.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design LOS

$v_p = (V$ or $DDHV) / (PHF$ x N x f_{HV} x $f_p)$ pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3984

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3270-EB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =　　　ft

V_u =　　　veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	925
Deceleration Lane Length L_D	
Freeway Volume, V_F	1857
Ramp Volume, V_R	471
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =　　　ft

V_D =　　　veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1857	0.90	Level	11	0	0.948	1.00	2177
Ramp	471	0.90	Level	6	0	0.971	1.00	539
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =　　　(Equation 13-6 or 13-7)

P_{FM} =　1.000　using Equation (Exhibit 13-6)

V_{12} =　2177　pc/h

V_3 or V_{av34}　　0　pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =　　　pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =　　　(Equation 13-12 or 13-13)

P_{FD} =　　　using Equation (Exhibit 13-7)

V_{12} =　　　pc/h

V_3 or V_{av34}　　　pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =　　　pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge:

	Actual	Capacity	LOS F?
V_{FO}	2716	Exhibit 13-8	No

Diverge:

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Merge:

	Actual	Max Desirable		Violation?
V_{R12}	2716	Exhibit 13-8	4600:All	No

Diverge:

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge:

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =　20.6 (pc/mi/ln)

LOS =　C (Exhibit 13-2)

Diverge:

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =　　(pc/mi/ln)

LOS =　　(Exhibit 13-2)

Speed Determination

Merge:

M_S =　0.334 (Exibit 13-11)

S_R =　57.3 mph (Exhibit 13-11)

S_0 =　N/A mph (Exhibit 13-11)

S =　57.3 mph (Exhibit 13-13)

Diverge:

D_s =　　(Exhibit 13-12)

S_R =　　mph (Exhibit 13-12)

S_0 =　　mph (Exhibit 13-12)

S =　　mph (Exhibit 13-13)

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F-3985

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3270-EB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			
☐ Yes ☐ On			
☑ No ☐ Off			
L_{up} = ft			
V_u = veh/h			

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	925
Deceleration Lane Length L_D	
Freeway Volume, V_F	1850
Ramp Volume, V_R	471
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp	
☐ Yes ☐ On	
☑ No ☐ Off	
L_{down} = ft	
V_D = veh/h	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1850	0.90	Level	11	0	0.948	1.00	2169
Ramp	471	0.90	Level	5	0	0.976	1.00	536
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 2169 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge

	Actual	Capacity	LOS F?
V_{FO}	2705	Exhibit 13-8	No

Diverge

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Merge

	Actual	Max Desirable		Violation?
V_{R12}	2705	Exhibit 13-8	4600:All	No

Diverge

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   20.5 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Diverge

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination

Merge

M_S =   0.333 (Exibit 13-11)

S_R =   57.3 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   57.3 mph (Exhibit 13-13)

Diverge

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-3986

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3280-EB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	2	☐ Yes ☐ On	
☑ No ☐ Off	Ramp Number of Lanes, N	1	☑ No ☐ Off	
	Acceleration Lane Length, L_A	625		
L_{up} = ft	Deceleration Lane Length L_D		L_{down} = ft	
	Freeway Volume, V_F	2328		
V_u = veh/h	Ramp Volume, V_R	345	V_D = veh/h	
	Freeway Free-Flow Speed, S_{FF}	65.0		
	Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2328	0.90	Level	11	0	0.948	1.00	2729
Ramp	345	0.90	Level	20	0	0.909	1.00	422
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   1.000   using Equation (Exhibit 13-6)
V_{12} =   2729   pc/h
V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   using Equation (Exhibit 13-7)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3151	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3151	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   25.9 (pc/mi/ln)
LOS =   C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.356 (Exibit 13-11)
S_R =   56.8 mph (Exhibit 13-11)
S_0 =   N/A mph (Exhibit 13-11)
S =   56.8 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)
S_R =   mph (Exhibit 13-12)
S_0 =   mph (Exhibit 13-12)
S =   mph (Exhibit 13-13)

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F-3987

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3280-EB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	2	☐ Yes ☐ On	
	Ramp Number of Lanes, N	1		
☑ No ☐ Off	Acceleration Lane Length, L_A	625	☑ No ☐ Off	
	Deceleration Lane Length L_D			
L_{up} = ft	Freeway Volume, V_F	2321	L_{down} = ft	
	Ramp Volume, V_R	667		
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	65.0	V_D = veh/h	
	Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2321	0.90	Level	11	0	0.948	1.00	2721
Ramp	667	0.90	Level	9	0	0.957	1.00	774
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   2721   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3495	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3495	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   28.5 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.393 (Exibit 13-11)

S_R =   56.0 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   56.0 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-3988

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*
Agency or Company	*Atkins*
Date Performed	*7/25/2014*
Analysis Time Period	*AM Peak*

Project Description *Navy Base ICTF*

Site Information

Highway/Direction of Travel	*I-526 EB*
From/To	*3290-LongPt.toUS17/Hungryneck*
Jurisdiction	
Analysis Year	*2018 Build - River Center Site*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*2673*	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	*0.90*	
%Trucks and Buses, P_T	*9*	
%RVs, P_R	*0*	
General Terrain:	*Level*	
Grade % Length	*mi*	
Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1552	pc/h/ln
S	*64.7*	mph
D = v_p / S	*24.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3989

BASIC FREEWAY SEGMENTS WORKSHEET

General Information | Site Information

Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3290-LongPt.toUS17/Hungryneck*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*2988*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*7*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs | Calc Speed Adj and FFS

Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures | Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) = *1718* pc/h/ln

S = *63.6* mph

D = v_p / S = *27.0* pc/mi/ln

LOS = *D*

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary | Factor Location

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-3990

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3300-EB Off to US17/Hungryneck
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	225
Freeway Volume, V_F	2673
Ramp Volume, V_R	1147
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2673	0.90	Level	9	0	0.957	1.00	3104
Ramp	1147	0.90	Level	4	0	0.980	1.00	1300
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   3104 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	3104	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1804	Exhibit 13-8	4500	No
V_R	1300	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	3104	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   28.9 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.415 (Exhibit 13-12)

S_R =   49.6 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   49.6 mph (Exhibit 13-13)

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F-3991

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information
Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3300-EB Off to US17/Hungryneck
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp				Downstream Adj Ramp	
☐ Yes	☐ On	Freeway Number of Lanes, N	2	☐ Yes	☐ On
☑ No	☐ Off	Ramp Number of Lanes, N	1	☑ No	☐ Off
		Acceleration Lane Length, L_A			
L_{up} = ft		Deceleration Lane Length L_D	225	L_{down} = ft	
		Freeway Volume, V_F	2988		
V_u = veh/h		Ramp Volume, V_R	982	V_D = veh/h	
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2988	0.90	Level	7	0	0.966	1.00	3436
Ramp	982	0.90	Level	4	0	0.980	1.00	1113
UpStream								
DownStream								

Merge Areas
Diverge Areas

Estimation of v_{12} (Merge)

$V_{12} = V_F (P_{FM})$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation   (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 3436 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	3436	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	2323	Exhibit 13-8	4500	No
V_R	1113	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	3436	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = 31.8 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)
S_R = mph (Exhibit 13-11)
S_0 = mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S = 0.398 (Exhibit 13-12)
S_R = 49.8 mph (Exhibit 13-12)
S_0 = N/A mph (Exhibit 13-12)
S = 49.8 mph (Exhibit 13-13)

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F-3992

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3310-US17/Hungryneck to US17
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1526	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	7	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   877   pc/h/ln

S   55.0   mph

D = v_p / S   15.9   pc/mi/ln

LOS   B

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S   - Speed
V - Hourly volume   D   - Density
v_p - Flow rate   FFS - Free-flow speed
LOS   - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

HCS 2010™   Version 6.41   Generated: 12/9/2014   9:24 AM

F-3993

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*	
Agency or Company	*Atkins*	
Date Performed	*7/25/2014*	
Analysis Time Period	*PM Peak*	

Site Information

Highway/Direction of Travel	*I-526 EB*
From/To	*3310-US17/Hungryneck to US17*
Jurisdiction	
Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*2006*	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	*0.90*	
%Trucks and Buses, P_T	*6*	
%RVs, P_R	*0*	
General Terrain:	*Level*	
Grade % Length	*mi*	
Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ *0.971*	

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$

	1148	pc/h/ln
S	*55.0*	mph
D = v_p / S	*20.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3994

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3320-EB Off to US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ____ ft

V_u = ____ veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	250
Freeway Volume, V_F	1526
Ramp Volume, V_R	1060
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ____ ft

V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1526	0.90	Level	7	0	0.966	1.00	1755
Ramp	1060	0.90	Level	13	0	0.939	1.00	1254
UpStream								
DownStream								

Merge Areas / Diverge Areas

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = ____ (Equation 13-6 or 13-7)

P_{FM} = ____ using Equation (Exhibit 13-6)

V_{12} = ____ pc/h

V_3 or V_{av34} = ____ pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = ____ (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1755 pc/h

V_3 or V_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

	Actual	Capacity		LOS F?
V_F	1755	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	501	Exhibit 13-8	4500	No
V_R	1254	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable		Violation?
V_{12}	1755	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = ____ (pc/mi/ln)

LOS = ____ (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = 17.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = ____ (Exibit 13-11)

S_R = ____ mph (Exhibit 13-11)

S_0 = ____ mph (Exhibit 13-11)

S = ____ mph (Exhibit 13-13)

D_s = 0.411 (Exhibit 13-12)

S_R = 49.7 mph (Exhibit 13-12)

S_0 = N/A mph (Exhibit 13-12)

S = 49.7 mph (Exhibit 13-13)

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F-3995

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3320-EB Off to US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			
☐ Yes	☐ On		
☑ No	☐ Off		
L_{up} =	ft		
V_u =	veh/h		

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	250
Freeway Volume, V_F	2006
Ramp Volume, V_R	1039
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp			
☐ Yes	☐ On		
☑ No	☐ Off		
L_{down} =	ft		
V_D =	veh/h		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2006	0.90	Level	6	0	0.971	1.00	2296
Ramp	1039	0.90	Level	11	0	0.948	1.00	1218
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   2296 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	2296	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1078	Exhibit 13-8	4500	No
V_R	1218	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	2296	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   21.7 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.408 (Exhibit 13-12)

S_R =   49.7 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   49.7 mph (Exhibit 13-13)

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F-3996

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Highway/Direction of Travel	I-526 EB
Agency or Company	Atkins	From/To	3325-US17 SB Off to US17 SB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	466	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	7	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

$v_p = (V \text{ or DDHV}) / (PHF \times N \times f_{HV} \times f_p)$ 268   pc/h/ln

S	55.0	mph
$D = v_p / S$	4.9	pc/mi/ln
LOS	A	

Design (N)

Design LOS

$v_p = (V \text{ or DDHV}) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S		mph
$D = v_p / S$		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3997

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	I-526 EB
From/To	3325-US17 SB Off to US17 SB On
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	967	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R		1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$		0.971

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	553	pc/h/ln
S	55.0	mph
D = v_p / S	10.1	pc/mi/ln
LOS	A	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-3998

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3330-EB On from US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	725
Deceleration Lane Length L_D	
Freeway Volume, V_F	466
Ramp Volume, V_R	359
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	466	0.90	Level	7	0	0.966	1.00	536
Ramp	359	0.90	Level	3	0	0.985	1.00	405
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} | Estimation of v_{12}

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000 using Equation (Exhibit 13-6)

V_{12} =   536 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	941	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	941	Exhibit 13-8	4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) | Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   8.1 (pc/mi/ln)

LOS =   A (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination | Speed Determination

M_S =   0.295 (Exibit 13-11)

S_R =   51.2 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   51.2 mph (Exhibit 13-13)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-3999

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3330-EB On from US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description	Navy Base ICTF

Inputs

Upstream Adj Ramp			Freeway Number of Lanes, N	2		Downstream Adj Ramp	
			Ramp Number of Lanes, N	1			
☐ Yes	☐ On		Acceleration Lane Length, L_A	725		☐ Yes	☐ On
			Deceleration Lane Length L_D			☑ No	☐ Off
☑ No	☐ Off		Freeway Volume, V_F	967			
L_{up} = ft			Ramp Volume, V_R	290		L_{down} = ft	
			Freeway Free-Flow Speed, S_{FF}	55.0			
V_u = veh/h			Ramp Free-Flow Speed, S_{FR}	25.0		V_D = veh/h	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	967	0.90	Level	6	0	0.971	1.00	1107
Ramp	290	0.90	Level	3	0	0.985	1.00	327
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} | ### Estimation of v_{12}

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 1107 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	1434	Exhibit 13-8	No

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1434	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 12.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = 0.301 (Exibit 13-11)

S_R = 51.1 mph (Exhibit 13-11)

S_0 = N/A mph (Exhibit 13-11)

S = 51.1 mph (Exhibit 13-13)

Speed Determination

D_s = (Exhibit 13-12)

S_R = mph (Exhibit 13-12)

S_0 = mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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F-4000

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3340-EB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp
- [ ] Yes [ ] On
- [x] No   [ ] Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	550
Deceleration Lane Length L_D	
Freeway Volume, V_F	825
Ramp Volume, V_R	24
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
- [ ] Yes [ ] On
- [x] No   [ ] Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	825	0.90	Level	7	0	0.966	1.00	949
Ramp	24	0.90	Level	4	0	0.980	1.00	27
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)
$$V_{12} = V_F (P_{FM})$$
- L_{EQ} =   (Equation 13-6 or 13-7)
- P_{FM} = 1.000 using Equation (Exhibit 13-6)
- V_{12} = 949 pc/h
- V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? [ ] Yes [x] No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 [ ] Yes [x] No
- If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)
$$V_{12} = V_R + (V_F - V_R)P_{FD}$$
- L_{EQ} =   (Equation 13-12 or 13-13)
- P_{FD} =   using Equation (Exhibit 13-7)
- V_{12} =   pc/h
- V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
- Is V_3 or V_{av34} > 2,700 pc/h? [ ] Yes [ ] No
- Is V_3 or V_{av34} > 1.5 * V_{12}/2 [ ] Yes [ ] No
- If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	976	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	976	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge
$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$
- D_R = 9.6 (pc/mi/ln)
- LOS = A (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge
$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$
- D_R =   (pc/mi/ln)
- LOS =   (Exhibit 13-2)

Speed Determination — Merge
- M_S = 0.282 (Exibit 13-11)
- S_R = 51.3 mph (Exhibit 13-11)
- S_0 = N/A mph (Exhibit 13-11)
- S = 51.3 mph (Exhibit 13-13)

Speed Determination — Diverge
- D_s =   (Exhibit 13-12)
- S_R =   mph (Exhibit 13-12)
- S_0 =   mph (Exhibit 13-12)
- S =   mph (Exhibit 13-13)

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F-4001

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3340-EB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp	Freeway Number of Lanes, N	2	Downstream Adj Ramp
☐ Yes ☐ On	Ramp Number of Lanes, N	1	☐ Yes ☐ On
	Acceleration Lane Length, L_A	550	
☑ No ☐ Off	Deceleration Lane Length L_D		☑ No ☐ Off
	Freeway Volume, V_F	1257	
L_{up} = ft	Ramp Volume, V_R	32	L_{down} = ft
	Freeway Free-Flow Speed, S_{FF}	55.0	
V_u = veh/h	Ramp Free-Flow Speed, S_{FR}	45.0	V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1257	0.90	Level	6	0	0.971	1.00	1439
Ramp	32	0.90	Level	3	0	0.985	1.00	36
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   1.000   using Equation (Exhibit 13-6)
V_{12} =   1439   pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   using Equation (Exhibit 13-7)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	1475	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1475	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   13.5 (pc/mi/ln)
LOS =   B (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.289 (Exibit 13-11)
S_R =   51.2 mph (Exhibit 13-11)
S_0 =   N/A mph (Exhibit 13-11)
S =   51.2 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)
S_R =   mph (Exhibit 13-12)
S_0 =   mph (Exhibit 13-12)
S =   mph (Exhibit 13-13)

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F-4002

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information   Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4010-WB Off to US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	300
Freeway Volume, V_F	1051
Ramp Volume, V_R	305
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1051	0.90	Level	7	0	0.966	1.00	1209
Ramp	305	0.90	Level	13	0	0.939	1.00	361
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} | ### Estimation of v_{12}

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   1209 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | ### Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	1209	Exhibit 13-8 / 4500	No
$V_{FO} = V_F - V_R$	848	Exhibit 13-8 / 4500	No
V_R	361	Exhibit 13-10 / 2100	No

Flow Entering Merge Influence Area | ### Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	1209	Exhibit 13-8 / 4400:All	No

Level of Service Determination (if not F) | ### Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   11.9 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

Speed Determination | ### Speed Determination

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

D_s =   0.330 (Exhibit 13-12)

S_R =   50.7 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   50.7 mph (Exhibit 13-13)

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F-4003

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4010-WB Off to US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	300
Freeway Volume, V_F	1067
Ramp Volume, V_R	436
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1067	0.90	Level	6	0	0.971	1.00	1221
Ramp	436	0.90	Level	8	0	0.962	1.00	504
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   1221 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	1221	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	717	Exhibit 13-8	4500	No
V_R	504	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	1221	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   12.1 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.343 (Exhibit 13-12)

S_R =   50.5 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   50.5 mph (Exhibit 13-13)

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F-4004

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4015-US17 NB off to US17 NB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	746	veh/h	Peak-Hour Factor, PHF	0.90		
AADT		veh/day	%Trucks and Buses, P_T	7		
Peak-Hr Prop. of AADT, K			%RVs, P_R	0		
Peak-Hr Direction Prop, D			General Terrain:	Level		
DDHV = AADT x K x D		veh/h	Grade % Length	mi		
			Up/Down %			

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft			
Number of Lanes, N	2		f_{LW}		mph
Total Ramp Density, TRD		ramps/mi	f_{LC}		mph
			TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   429   pc/h/ln

S   55.0   mph

D = v_p / S   7.8   pc/mi/ln

LOS   A

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS   - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4005

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4015-US17 NB off to US17 NB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	631	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.971

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	361	pc/h/ln
S	55.0	mph
D = v_p / S	6.6	pc/mi/ln
LOS	A	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4006

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A	775	
Deceleration Lane Length L_D		
Freeway Volume, V_F	746	
Ramp Volume, V_R	907	
Freeway Free-Flow Speed, S_{FF}	55.0	
Ramp Free-Flow Speed, S_{FR}	25.0	

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	746	0.90	Level	7	0	0.966	1.00	858
Ramp	907	0.90	Level	5	0	0.976	1.00	1033
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000 using Equation (Exhibit 13-6)

V_{12} =   858 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	1891	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1891	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   14.9 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.308 (Exibit 13-11)

S_R =   51.0 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   51.0 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4007

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description Navy Base ICTF			

Inputs

Upstream Adj Ramp				Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	2		☐ Yes ☐ On	
	Ramp Number of Lanes, N	1			
☑ No ☐ Off	Acceleration Lane Length, L_A	775		☑ No ☐ Off	
	Deceleration Lane Length L_D				
L_{up} = ft	Freeway Volume, V_F	631		L_{down} = ft	
	Ramp Volume, V_R	886			
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	55.0		V_D = veh/h	
	Ramp Free-Flow Speed, S_{FR}	25.0			

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	631	0.90	Level	6	0	0.971	1.00	722
Ramp	886	0.90	Level	4	0	0.980	1.00	1004
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 722 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	1726	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1726	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   13.6 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination — Merge

M_S =   0.304 (Exibit 13-11)

S_R =   51.0 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   51.0 mph (Exhibit 13-13)

Speed Determination — Diverge

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4008

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4030-US17 to US17/Hungryneck*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description	*Navy Base ICTF*

☑ Oper.(LOS)　　　　　　☐ Des.(N)　　　　　　☐ Planning Data

Flow Inputs

Volume, V	*1653*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*7*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade　% 　　Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs			**Calc Speed Adj and FFS**		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

$v_p = (V$ or DDHV$) / ($PHF x N x f_{HV} x f_p) ... *950* pc/h/ln

S ... *55.0* mph

$D = v_p / S$ ... *17.3* pc/mi/ln

LOS ... *B*

Design (N)

Design LOS

$v_p = (V$ or DDHV$) / ($PHF x N x f_{HV} x f_p) ... pc/h/ln

S ... mph

$D = v_p / S$ ... pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4009

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4030-US17 to US17/Hungryneck
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1517	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.971

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft			
Number of Lanes, N	2		f_{LW}		mph
Total Ramp Density, TRD		ramps/mi	f_{LC}		mph
			TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   868   pc/h/ln

S	55.0	mph
D = v_p / S	15.8	pc/mi/ln
LOS	B	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4010

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17/Hungrynec
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ____ ft

V_u = ____ veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	425
Deceleration Lane Length L_D	
Freeway Volume, V_F	1653
Ramp Volume, V_R	867
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ____ ft

V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1653	0.90	Level	7	0	0.966	1.00	1901
Ramp	867	0.90	Level	25	0	0.889	1.00	1084
UpStream								
DownStream								

Merge Areas / Diverge Areas

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**

Merge Areas — Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = ____ (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1901 pc/h

V_3 or V_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas — Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = ____ (Equation 13-12 or 13-13)

P_{FD} = ____ using Equation (Exhibit 13-7)

V_{12} = ____ pc/h

V_3 or V_{av34} = ____ pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge

	Actual	Capacity	LOS F?
V_{FO}	2985	Exhibit 13-8	No

Diverge

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2985	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 25.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = ____ (pc/mi/ln)

LOS = ____ (Exhibit 13-2)

Speed Determination

Merge

M_S = 0.360 (Exibit 13-11)

S_R = 50.3 mph (Exhibit 13-11)

S_0 = N/A mph (Exhibit 13-11)

S = 50.3 mph (Exhibit 13-13)

Diverge

D_s = ____ (Exhibit 13-12)

S_R = ____ mph (Exhibit 13-12)

S_0 = ____ mph (Exhibit 13-12)

S = ____ mph (Exhibit 13-13)

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F-4011

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17/Hungrynec
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp
☐ Yes   ☐ On
☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N — 2
Ramp Number of Lanes, N — 1
Acceleration Lane Length, L_A — 425
Deceleration Lane Length L_D —
Freeway Volume, V_F — 1517
Ramp Volume, V_R — 1254
Freeway Free-Flow Speed, S_{FF} — 55.0
Ramp Free-Flow Speed, S_{FR} — 45.0

Downstream Adj Ramp
☐ Yes   ☐ On
☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1517	0.90	Level	6	0	0.971	1.00	1736
Ramp	1254	0.90	Level	15	0	0.930	1.00	1498
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | Estimation of v_{12} (Diverge)

Merge Areas — Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   1.000   using Equation (Exhibit 13-6)
V_{12} =   1736 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas — Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   using Equation (Exhibit 13-7)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge

	Actual	Capacity	LOS F?
V_{FO}	3234	Exhibit 13-8	No

Diverge

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	3234	Exhibit 13-8 4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   27.3 (pc/mi/ln)
LOS =   C (Exhibit 13-2)

Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Speed Determination

Merge

M_S =   0.382 (Exibit 13-11)
S_R =   50.0 mph (Exhibit 13-11)
S_0 =   N/A mph (Exhibit 13-11)
S =   50.0 mph (Exhibit 13-13)

Diverge

D_s =   (Exhibit 13-12)
S_R =   mph (Exhibit 13-12)
S_0 =   mph (Exhibit 13-12)
S =   mph (Exhibit 13-13)

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F-4012

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	AJR		Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*		From/To	*4050-US17/Hungryneck to LongPt*
Date Performed	*7/25/2014*		Jurisdiction	
Analysis Time Period	*AM Peak*		Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*2520*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*9*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

				Calc Speed Adj and FFS		
Lane Width		ft				
Rt-Side Lat. Clearance		ft		f_{LW}		mph
Number of Lanes, N	*2*			f_{LC}		mph
Total Ramp Density, TRD		ramps/mi		TRD Adjustment		mph
FFS (measured)	*65.0*	mph		FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph				

LOS and Performance Measures

Design (N)

Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1463*	pc/h/ln	Design LOS		
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*64.9*	mph	S		mph
D = v_p / S	*22.5*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*C*		Required Number of Lanes, N		

Glossary

Factor Location

N - Number of lanes	S - Speed		E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density		E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed		f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service speed	BFFS - Base free-flow speed		LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume				

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F-4013

BASIC FREEWAY SEGMENTS WORKSHEET

General Information			*Site Information*	
Analyst	AJR		Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins		From/To	4050-US17/Hungryneck to LongPt
Date Performed	7/25/2014		Jurisdiction	
Analysis Time Period	PM Peak		Analysis Year	2018 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2771	veh/h	Peak-Hour Factor, PHF	0.90
AADT		veh/day	%Trucks and Buses, P_T	7
Peak-Hr Prop. of AADT, K			%RVs, P_R	0
Peak-Hr Direction Prop, D			General Terrain:	Level
DDHV = AADT x K x D		veh/h	Grade % Length	mi
			Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1593   pc/h/ln

S   64.5   mph

D = v_p / S   24.7   pc/mi/ln

LOS   C

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4014

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4060-WB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp					Downstream Adj Ramp	
☐ Yes	☐ On	Freeway Number of Lanes, N	2		☐ Yes	☐ On
		Ramp Number of Lanes, N	1			
☑ No	☐ Off	Acceleration Lane Length, L_A			☑ No	☐ Off
		Deceleration Lane Length L_D	250			
L_{up} =	ft	Freeway Volume, V_F	2520		L_{down} =	ft
		Ramp Volume, V_R	516			
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	65.0		V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0			

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2520	0.90	Level	9	0	0.957	1.00	2926
Ramp	516	0.90	Level	17	0	0.922	1.00	622
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | ### Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation   (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   1.000 using Equation (Exhibit 13-7)
V_{12} =   2926 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	2926	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2304	Exhibit 13-8	4700	No
V_R	622	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	2926	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   27.2 (pc/mi/ln)
LOS =   C (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.354 (Exhibit 13-12)
S_R =   56.9 mph (Exhibit 13-12)
S_0 =   N/A mph (Exhibit 13-12)
S =   56.9 mph (Exhibit 13-13)

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F-4015

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4060-WB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp
☐ Yes   ☐ On
☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	250
Freeway Volume, V_F	2771
Ramp Volume, V_R	1177
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes   ☐ On
☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2771	0.90	Level	7	0	0.966	1.00	3187
Ramp	1177	0.90	Level	6	0	0.971	1.00	1347
UpStream								
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation   (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   1.000 using Equation (Exhibit 13-7)
V_{12} =   3187 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	3187	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	1840	Exhibit 13-8	4700	No
V_R	1347	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	3187	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   29.4 (pc/mi/ln)
LOS =   D (Exhibit 13-2)

Speed Determination

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

D_s =   0.419 (Exhibit 13-12)
S_R =   55.4 mph (Exhibit 13-12)
S_0 =   N/A mph (Exhibit 13-12)
S =   55.4 mph (Exhibit 13-13)

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F-4016

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	AJR		Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins		From/To	4065-LongPt Off to LongPtEB On
Date Performed	4/25/2014		Jurisdiction	
Analysis Time Period	AM Peak		Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2004	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	11	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00		E_R	1.2
E_T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1175	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	65.0	mph	S	mph
D = v_p / S	18.1	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	C		Required Number of Lanes, N	

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4017

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4065-LongPt Off to LongPtEB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1594	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	11	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length mi		
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ 0.948	

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   934   pc/h/ln

S   65.0   mph

D = v_p / S   14.4   pc/mi/ln

LOS   B

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed	
V - Hourly volume	D - Density	
v_p - Flow rate	FFS - Free-flow speed	
LOS - Level of service speed	BFFS - Base free-flow	
DDHV - Directional design hour volume		

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

F-4018

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4070-WB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description　Navy Base ICTF			

Inputs

Upstream Adj Ramp

☐ Yes　☐ On

☑ No　☐ Off

L_{up} =　　ft

V_u =　　veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	950
Deceleration Lane Length L_D	
Freeway Volume, V_F	2004
Ramp Volume, V_R	601
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes　☐ On

☑ No　☐ Off

L_{down} =　　ft

V_D =　　veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2004	0.90	Level	11	0	0.948	1.00	2349
Ramp	601	0.90	Level	20	0	0.909	1.00	735
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | ### Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} =　　(Equation 13-6 or 13-7)	L_{EQ} =　　(Equation 13-12 or 13-13)
P_{FM} =　1.000　using Equation (Exhibit 13-6)	P_{FD} =　　using Equation (Exhibit 13-7)
V_{12} =　2349　pc/h	V_{12} =　　pc/h
V_3 or V_{av34}　　0　pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34}　　pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} =　　pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} =　　pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3084	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3084	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R =　23.2 (pc/mi/ln)

LOS =　C (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R =　(pc/mi/ln)

LOS =　(Exhibit 13-2)

Speed Determination (Merge)

M_S =　0.359 (Exibit 13-11)

S_R =　56.7 mph (Exhibit 13-11)

S_0 =　N/A mph (Exhibit 13-11)

S =　56.7 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =　(Exhibit 13-12)

S_R =　mph (Exhibit 13-12)

S_0 =　mph (Exhibit 13-12)

S =　mph (Exhibit 13-13)

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F-4019

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4070-WB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	2	☐ Yes ☐ On	
	Ramp Number of Lanes, N	1		
☑ No ☐ Off	Acceleration Lane Length, L_A	950	☑ No ☐ Off	
	Deceleration Lane Length L_D			
L_{up} = ft	Freeway Volume, V_F	1594	L_{down} = ft	
	Ramp Volume, V_R	668		
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	65.0	V_D = veh/h	
	Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1594	0.90	Level	11	0	0.948	1.00	1869
Ramp	668	0.90	Level	15	0	0.930	1.00	798
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 1869 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	2667	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2667	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   20.0 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination — Merge

M_S =   0.330 (Exibit 13-11)

S_R =   57.4 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   57.4 mph (Exhibit 13-13)

Speed Determination — Diverge

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4020

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4080-WB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description Navy Base ICTF			

Inputs

Upstream Adj Ramp		
☐ Yes	☐ On	
☑ No	☐ Off	

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	1025
Deceleration Lane Length L_D	
Freeway Volume, V_F	2605
Ramp Volume, V_R	1388
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp		
☐ Yes	☐ On	
☑ No	☐ Off	

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2605	0.90	Level	11	0	0.948	1.00	3054
Ramp	1388	0.90	Level	5	0	0.976	1.00	1581
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   3054   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	4635	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4635	Exhibit 13-8	4600:All	Yes

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   34.5 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.631 (Exibit 13-11)

S_R =   50.5 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   50.5 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4021

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4080-WB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A	1025	
Deceleration Lane Length L_D		
Freeway Volume, V_F	2262	
Ramp Volume, V_R	1007	
Freeway Free-Flow Speed, S_{FF}	65.0	
Ramp Free-Flow Speed, S_{FR}	45.0	

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2262	0.90	Level	11	0	0.948	1.00	2652
Ramp	1007	0.90	Level	6	0	0.971	1.00	1152
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge Areas)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   2652   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge Areas)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3804	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3804	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   28.2 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.404 (Exibit 13-11)

S_R =   55.7 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   55.7 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4022

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	I-526 WB
From/To	4090-Long Point to Island Park
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3993	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	11	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R		1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$		0.948

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	65.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	65.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	2340	pc/h/ln
S	52.5	mph
D = v_p / S	44.6	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4023

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4090-Long Point to Island Park
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3269	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	11	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	65.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	65.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1916	pc/h/ln
S	61.2	mph
D = v_p / S	31.3	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4024

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4100-WB Off to Island Park
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On
☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	775
Freeway Volume, V_F	3993
Ramp Volume, V_R	1099
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes   ☐ On
☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3993	0.90	Level	11	0	0.948	1.00	4681
Ramp	1099	0.90	Level	10	0	0.952	1.00	1282
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   1.000 using Equation (Exhibit 13-7)
V_{12} =   4681 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	4681	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	3399	Exhibit 13-8	4700	No
V_R	1282	Exhibit 13-10	1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	4681	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   37.5 (pc/mi/ln)
LOS =   E (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   0.673 (Exhibit 13-12)
S_R =   49.5 mph (Exhibit 13-12)
S_0 =   N/A mph (Exhibit 13-12)
S =   49.5 mph (Exhibit 13-13)

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F-4025

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4100-WB Off to Island Park
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp	Freeway Number of Lanes, N	2	Downstream Adj Ramp
☐ Yes ☐ On	Ramp Number of Lanes, N	1	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off
	Deceleration Lane Length L_D	775	
L_{up} = ft	Freeway Volume, V_F	3269	L_{down} = ft
	Ramp Volume, V_R	595	
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	65.0	V_D = veh/h
	Ramp Free-Flow Speed, S_{FR}	25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3269	0.90	Level	11	0	0.948	1.00	3832
Ramp	595	0.90	Level	16	0	0.926	1.00	714
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation   (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   1.000 using Equation (Exhibit 13-7)
V_{12} =   3832 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	3832	Exhibit 13-8 4700	No
$V_{FO} = V_F - V_R$	3118	Exhibit 13-8 4700	No
V_R	714	Exhibit 13-10 1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	3832	Exhibit 13-8 4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   30.2 (pc/mi/ln)
LOS =   D (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   0.622 (Exhibit 13-12)
S_R =   50.7 mph (Exhibit 13-12)
S_0 =   N/A mph (Exhibit 13-12)
S =   50.7 mph (Exhibit 13-13)

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F-4026

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR		
Agency or Company	Atkins		
Date Performed	7/25/2014		
Analysis Time Period	AM Peak		

Site Information

Highway/Direction of Travel	I-526 WB
From/To	4105 - Is. Pk Off to Is. Pk On
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2894	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	11	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R		1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$		0.948

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	65.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	65.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1696	pc/h/ln
S	63.8	mph
D = v_p / S	26.6	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4027

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4105 - Is. Pk Off to Is. Pk On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2674	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	11	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ 0.948	

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	65.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	65.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1567	pc/h/ln
S	64.6	mph
D = v_p / S	24.3	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4028

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4110-WB On from Island Park Dr
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp		
☐ Yes	☐ On	
☑ No	☐ Off	
L_{up} =	ft	
V_u =	veh/h	

Freeway Number of Lanes, N	2	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A	1400	
Deceleration Lane Length L_D		
Freeway Volume, V_F	2894	
Ramp Volume, V_R	543	
Freeway Free-Flow Speed, S_{FF}	65.0	
Ramp Free-Flow Speed, S_{FR}	45.0	

Downstream Adj Ramp		
☐ Yes	☐ On	
☑ No	☐ Off	
L_{down} =	ft	
V_D =	veh/h	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2894	0.90	Level	11	0	0.948	1.00	3392
Ramp	543	0.90	Level	6	0	0.971	1.00	621
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F(P_{FM})$$

L_{EQ} =　　　　　(Equation 13-6 or 13-7)

P_{FM} =　　1.000　using Equation (Exhibit 13-6)

V_{12} =　　3392　pc/h

V_3 or V_{av34}　　0　pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =　　pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =　　　　　(Equation 13-12 or 13-13)

P_{FD} =　　using Equation (Exhibit 13-7)

V_{12} =　　pc/h

V_3 or V_{av34}　　pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =　　pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	4013	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4013	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =　27.7 (pc/mi/ln)

LOS =　C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =　(pc/mi/ln)

LOS =　(Exhibit 13-2)

Speed Determination (Merge)

M_S =　0.411 (Exibit 13-11)

S_R =　55.6 mph (Exhibit 13-11)

S_0 =　N/A mph (Exhibit 13-11)

S =　55.6 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =　(Exhibit 13-12)

S_R =　mph (Exhibit 13-12)

S_0 =　mph (Exhibit 13-12)

S =　mph (Exhibit 13-13)

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F-4029

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4110-WB On from Island Park Dr
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			
☐ Yes	☐ On	Freeway Number of Lanes, N	2
		Ramp Number of Lanes, N	1
☑ No	☐ Off	Acceleration Lane Length, L_A	1400
		Deceleration Lane Length L_D	
L_{up} = ft		Freeway Volume, V_F	2674
		Ramp Volume, V_R	630
V_u = veh/h		Freeway Free-Flow Speed, S_{FF}	65.0
		Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} =   ft
V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2674	0.90	Level	11	0	0.948	1.00	3135
Ramp	630	0.90	Level	5	0	0.976	1.00	718
UpStream								
DownStream								

Merge Areas	**Diverge Areas**
Estimation of v_{12}	*Estimation of v_{12}*

Merge Areas — Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   1.000   using Equation (Exhibit 13-6)
V_{12} =   3135   pc/h
V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas — Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   using Equation (Exhibit 13-7)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3853	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3853	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   26.4 (pc/mi/ln)
LOS =   C (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Speed Determination — Merge

M_S =   0.379 (Exibit 13-11)
S_R =   56.3 mph (Exhibit 13-11)
S_0 =   N/A mph (Exhibit 13-11)
S =   56.3 mph (Exhibit 13-13)

Speed Determination — Diverge

D_s =   (Exhibit 13-12)
S_R =   mph (Exhibit 13-12)
S_0 =   mph (Exhibit 13-12)
S =   mph (Exhibit 13-13)

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F-4030

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*
Agency or Company	*Atkins*
Date Performed	*7/25/2014*
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*I-526 WB*
From/To	*4120-IslandParktoClementsFerry*
Jurisdiction	
Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS)　　　☐ Des.(N)　　　☐ Planning Data

Flow Inputs

Volume, V	*3437*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*10*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade　%　Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	2005	pc/h/ln
S	*59.8*	mph
D = v_p / S	*33.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes　　S - Speed
V - Hourly volume　　D - Density
v_p - Flow rate　　FFS - Free-flow speed
LOS - Level of service　BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12　　f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13　f_{LC} - Exhibit 11-9
f_p - Page 11-18　　TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4031

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	AJR		Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins		From/To	4120-IslandParktoClementsFerry
Date Performed	7/25/2014		Jurisdiction	
Analysis Time Period	PM Peak		Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3304	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	9	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.957

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	65.0	mph	FFS	65.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1918   pc/h/ln

S	61.2	mph
D = v_p / S	31.3	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S	mph
D = v_p / S	pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4032

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4130-WB Off to Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	240
Freeway Volume, V_F	3437
Ramp Volume, V_R	444
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3437	0.90	Level	10	0	0.952	1.00	4010
Ramp	444	0.90	Level	17	0	0.922	1.00	535
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   4010 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks

	Actual	Capacity	LOS F?
V_F	4010	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3475	Exhibit 13-8	4600	No
V_R	535	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	4010	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   36.6 (pc/mi/ln)

LOS =   E (Exhibit 13-2)

Speed Determination

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination

D_s =   0.346 (Exhibit 13-12)

S_R =   53.8 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   53.8 mph (Exhibit 13-13)

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F-4033

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4130-WB Off to Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	2	☐ Yes ☐ On	
	Ramp Number of Lanes, N	1		
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off	
	Deceleration Lane Length L_D	240		
L_{up} = ft	Freeway Volume, V_F	3304	L_{down} = ft	
	Ramp Volume, V_R	368		
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D = veh/h	
	Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3304	0.90	Level	9	0	0.957	1.00	3836
Ramp	368	0.90	Level	17	0	0.922	1.00	444
UpStream								
DownStream								

Merge Areas	**Diverge Areas**
Estimation of v_{12}	*Estimation of v_{12}*

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3836 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No	Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks				*Capacity Checks*			
	Actual	Capacity	LOS F?		Actual	Capacity	LOS F?
				V_F	3836	Exhibit 13-8 4600	No
V_{FO}		Exhibit 13-8		$V_{FO} = V_F - V_R$	3392	Exhibit 13-8 4600	No
				V_R	444	Exhibit 13-10 2100	No

Flow Entering Merge Influence Area				*Flow Entering Diverge Influence Area*			
	Actual	Max Desirable	Violation?		Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8		V_{12}	3836	Exhibit 13-8 4400:All	No

Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 35.1 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = E (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = (Exibit 13-11)	D_s = 0.338 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 53.9 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = N/A mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 53.9 mph (Exhibit 13-13)

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F-4034

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	AJR		Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins		From/To	4135-ClFerry Off to ClFerry On
Date Performed	7/25/2014		Jurisdiction	
Analysis Time Period	AM Peak		Analysis Year	2018 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2993	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	12	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1 + P_T(E_T - 1) + P_R(E_R - 1)]$ 0.943	

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1763   pc/h/ln

S	59.5	mph
D = v_p / S	29.6	pc/mi/ln
LOS	D	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4035

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4135-ClFerry Off to ClFerry On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2936	veh/h	Peak-Hour Factor, PHF	0.90
AADT		veh/day	%Trucks and Buses, P_T	12
Peak-Hr Prop. of AADT, K			%RVs, P_R	0
Peak-Hr Direction Prop, D			General Terrain:	Level
DDHV = AADT x K x D		veh/h	Grade % Length	mi
			Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.943

Speed Inputs / Calc Speed Adj and FFS

Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures / Design (N)

Operational (LOS)
$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ 1729   pc/h/ln
S   59.7   mph
D = v_p / S   29.0   pc/mi/ln
LOS   D

Design (N)
Design LOS
$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln
S   mph
D = v_p / S   pc/mi/ln
Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4036

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-526 WB
Analysis Year	2018 Build-River Center Site	Junction	From Clements Ferry
Analysis Time Period:	AM Peak	Segment ID	4140
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	60	60	45
Volume, V (veh/h)	2,993	4,017	1,024
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	12%	12%	20%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.94	0.91
Demand Flow Rate, v_p (pc/h/ln)	1,763	1,577	1,252
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,100
v/c ratio	0.77	0.69	0.60
Density, D_{MD} (pc/mi/ln)	30.9	27.6	21.9
LOS	D	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-526 WB
Analysis Year	2018 Build-River Center Site	Junction	From Clements Ferry
Analysis Time Period:	PM Peak	Segment ID	4140
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	60	60	45
Volume, V (veh/h)	2,936	3,315	379
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	12%	12%	45%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.94	0.82
Demand Flow Rate, v_p (pc/h/ln)	1,729	1,301	516
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,100
v/c ratio	0.75	0.57	0.25
Density, D_{MD} (pc/mi/ln)	30.3	22.8	9.0
LOS	D	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1) + P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF \cdot N \cdot f_{HV} \cdot f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175 \cdot v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4150-ClementsFerry to Virginia
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	4017	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	12	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.943

Speed Inputs | Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures | Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   2366   pc/h/ln

S	49.3	mph
D = v_p / S	47.9	pc/mi/ln
LOS	F	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln

Required Number of Lanes, N

Glossary | Factor Location

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

HCS 2010™   Version 6.41   Generated: 12/9/2014   9:59 AM

F-4039

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4150-ClementsFerry to Virginia
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3315	veh/h	Peak-Hour Factor, PHF	0.90		
AADT		veh/day	%Trucks and Buses, P_T	12		
Peak-Hr Prop. of AADT, K			%RVs, P_R	0		
Peak-Hr Direction Prop, D			General Terrain:	Level		
DDHV = AADT x K x D		veh/h	Grade % Length	mi		
			Up/Down %			

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T-1)+P_R(E_R-1)]$	0.943

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1952   pc/h/ln

S   57.7   mph

D = v_p / S   33.8   pc/mi/ln

LOS   D

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4040

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency/Company	Atkins	Weaving Segment Location	4160 - Virginia to Rhett
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1415ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2977	0.90	14	0	1.5	1.2	0.935	1.00	3539
V_{RF}	104	0.90	68	0	1.5	1.2	0.746	1.00	155
V_{FR}	1040	0.90	14	0	1.5	1.2	0.935	1.00	1236
V_{RR}	36	0.90	68	0	1.5	1.2	0.746	1.00	54
V_{NW}	3593							V =	4984
V_W	1391								
VR	0.279								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1391 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	1570 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	929 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2499 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	356

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4984 pc/h	Weaving intensity factor, W	0.354
Weaving segment capacity, c_w	5602 veh/h	Weaving segment speed, S	43.6 mph
Weaving segment v/c ratio	0.831	Average weaving speed, S_W	48.2 mph
Weaving segment density, D	38.1 pc/mi/ln	Average non-weaving speed, S_{NW}	42.0 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5361 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4041

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency/Company	Atkins	Weaving Segment Location	4160 - Virginia to Rhett
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1415ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2315	0.90	13	0	1.5	1.2	0.939	1.00	2739
V_{RF}	579	0.90	13	0	1.5	1.2	0.939	1.00	685
V_{FR}	1000	0.90	13	0	1.5	1.2	0.939	1.00	1183
V_{RR}	251	0.90	10	0	1.5	1.2	0.952	1.00	293
V_{NW}	3032							V =	4900
V_W	1868								
VR	0.381								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1868 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	2047 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	814 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2861 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	300

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4900 pc/h	Weaving intensity factor, W	0.394
Weaving segment capacity, c_w	5389 veh/h	Weaving segment speed, S	41.6 mph
Weaving segment v/c ratio	0.854	Average weaving speed, S_W	47.3 mph
Weaving segment density, D	39.3 pc/mi/ln	Average non-weaving speed, S_{NW}	38.7 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6471 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4042

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	*AJR*		Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*		From/To	*4165-Rhett Off to Rhett On*
Date Performed	*7/25/2014*		Jurisdiction	
Analysis Time Period	*AM Peak*		Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*3081*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*15*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1840*	pc/h/ln
S	*59.0*	mph
D = v_p / S	*31.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4043

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*
Agency or Company	*Atkins*
Date Performed	*7/25/2014*
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-526 WB*
From/To	*4165-Rhett Off to Rhett On*
Jurisdiction	
Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)　　　　　☐ Des.(N)　　　　　☐ Planning Data

Flow Inputs

Volume, V	*2894*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*14*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.935*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1720*	pc/h/ln
S	*59.7*	mph
D = v_p / S	*28.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4044

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4170-WB On from Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	2	☐ Yes ☐ On	
	Ramp Number of Lanes, N	1		
☑ No ☐ Off	Acceleration Lane Length, L_A	625	☑ No ☐ Off	
	Deceleration Lane Length L_D			
L_{up} = ft	Freeway Volume, V_F	3081	L_{down} = ft	
	Ramp Volume, V_R	719		
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D = veh/h	
	Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3081	0.90	Level	15	0	0.930	1.00	3680
Ramp	719	0.90	Level	7	0	0.966	1.00	827
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | *Estimation of v_{12}* (Diverge)

Merge Areas — Estimation of v_{12}

$$V_{12} = V_F(P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   1.000   using Equation (Exhibit 13-6)
V_{12} =   3680   pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas — Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   using Equation (Exhibit 13-7)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	4507	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4507	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$$

D_R =   36.3 (pc/mi/ln)
LOS =   E (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.618 (Exibit 13-11)
S_R =   48.9 mph (Exhibit 13-11)
S_0 =   N/A mph (Exhibit 13-11)
S =   48.9 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)
S_R =   mph (Exhibit 13-12)
S_0 =   mph (Exhibit 13-12)
S =   mph (Exhibit 13-13)

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F-4045

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4170-WB On from Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	625
Deceleration Lane Length L_D	
Freeway Volume, V_F	2894
Ramp Volume, V_R	589
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2894	0.90	Level	14	0	0.935	1.00	3441
Ramp	589	0.90	Level	7	0	0.966	1.00	677
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge Areas	Diverge Areas
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 3441 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	4118	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	4118	Exhibit 13-8 4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge:

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   33.4 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Diverge:

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination

Merge:

M_S =   0.504 (Exibit 13-11)

S_R =   50.9 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   50.9 mph (Exhibit 13-13)

Diverge:

D_S =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4046

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4180-Rhett to Rivers
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description _Navy Base ICTF_

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	3800	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	15	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.930

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ 2269 pc/h/ln

S	49.6	mph
D = v_p / S	45.8	pc/mi/ln
LOS	F	

Design (N)

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S		mph
D = v_p / S		pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4047

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4180-Rhett to Rivers*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*3483*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*14*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.935*

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	2070	pc/h/ln
S	*53.2*	mph
D = v_p / S	*38.9*	pc/mi/ln
LOS	*E*	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4048

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		**Site Information**	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4190-WB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description Navy Base ICTF			

Inputs

Upstream Adj Ramp			
☐ Yes	☐ On	Freeway Number of Lanes, N	2
		Ramp Number of Lanes, N	1
☑ No	☐ Off	Acceleration Lane Length, L_A	
		Deceleration Lane Length L_D	725
$L_{up} =$ ft		Freeway Volume, V_F	3800
		Ramp Volume, V_R	233
$V_u =$ veh/h		Freeway Free-Flow Speed, S_{FF}	55.0
		Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
$L_{down} =$ ft
$V_D =$ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3800	0.90	Level	15	0	0.930	1.00	4539
Ramp	233	0.90	Level	2	0	0.990	1.00	261
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge) | ### Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

$L_{EQ} =$ (Equation 13-6 or 13-7)
$P_{FM} =$ using Equation (Exhibit 13-6)
$V_{12} =$ pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or $V_{av34} > 2{,}700$ pc/h? ☐ Yes ☐ No
Is V_3 or $V_{av34} > 1.5 * V_{12}/2$ ☐ Yes ☐ No
If Yes, $V_{12a} =$ pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

$L_{EQ} =$ (Equation 13-12 or 13-13)
$P_{FD} =$ 1.000 using Equation (Exhibit 13-7)
$V_{12} =$ 4539 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or $V_{av34} > 2{,}700$ pc/h? ☐ Yes ☑ No
Is V_3 or $V_{av34} > 1.5 * V_{12}/2$ ☐ Yes ☑ No
If Yes, $V_{12a} =$ pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	4539	Exhibit 13-8 4500	Yes
$V_{FO} = V_F - V_R$	4278	Exhibit 13-8 4500	No
V_R	261	Exhibit 13-10 2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	4539	Exhibit 13-8 4400:All	Yes

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

$D_R =$ (pc/mi/ln)
LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

$D_R =$ 36.8 (pc/mi/ln)
LOS =   F (Exhibit 13-2)

Speed Determination — Merge

$M_S =$ (Exibit 13-11)
$S_R =$ mph (Exhibit 13-11)
$S_0 =$ mph (Exhibit 13-11)
$S =$ mph (Exhibit 13-13)

Speed Determination — Diverge

$D_s =$ 0.321 (Exhibit 13-12)
$S_R =$ 50.8 mph (Exhibit 13-12)
$S_0 =$ N/A mph (Exhibit 13-12)
$S =$ 50.8 mph (Exhibit 13-13)

F-4049

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4190-WB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	725
Freeway Volume, V_F	3483
Ramp Volume, V_R	163
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3483	0.90	Level	14	0	0.935	1.00	4141
Ramp	163	0.90	Level	2	0	0.990	1.00	183
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge Areas)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge Areas)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   4141 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	4141	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3958	Exhibit 13-8	4500	No
V_R	183	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	4141	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   33.3 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination

D_s =   0.314 (Exhibit 13-12)

S_R =   50.9 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   50.9 mph (Exhibit 13-13)

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F-4050

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information   Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4200-WB Off to Rivers SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	3567
Ramp Volume, V_R	215
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3567	0.90	Level	17	0	0.922	1.00	4300
Ramp	215	0.90	Level	6	0	0.971	1.00	246
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | ### Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   4300 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	4300	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	4054	Exhibit 13-8	4500	No
V_R	246	Exhibit 13-10	1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	4300	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   34.9 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.580 (Exhibit 13-12)

S_R =   47.5 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   47.5 mph (Exhibit 13-13)

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F-4051

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4200-WB Off to Rivers SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	3320
Ramp Volume, V_R	64
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3320	0.90	Level	15	0	0.930	1.00	3966
Ramp	64	0.90	Level	17	0	0.922	1.00	77
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   3966 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	3966	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3889	Exhibit 13-8	4500	No
V_R	77	Exhibit 13-10	1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	3966	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   32.1 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.565 (Exhibit 13-12)

S_R =   47.7 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   47.7 mph (Exhibit 13-13)

F-4052

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4205-RiversSB Off to Rivers On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3352	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	17	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.922

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2021	pc/h/ln	Design LOS		
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	53.8	mph	S		mph
D = v_p / S	37.6	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	E		Required Number of Lanes, N		

Glossary / Factor Location

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-4053

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*
Agency or Company	*Atkins*
Date Performed	*7/25/2014*
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-526 WB*
From/To	*4205-RiversSB Off to Rivers On*
Jurisdiction	
Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3256	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*15*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1945	pc/h/ln
S	*54.5*	mph
D = v_p / S	*35.7*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume

S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   10:12 AM

F-4054

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4210 - Rivers to I-26 WB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	725ft
Freeway free-flow speed, FFS	55 mph

Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2203	0.90	17	0	1.5	1.2	0.922	1.00	2656
V_{RF}	353	0.90	17	0	1.5	1.2	0.922	1.00	426
V_{FR}	1149	0.90	54	0	1.5	1.2	0.787	1.00	1621
V_{RR}	184	0.90	54	0	1.5	1.2	0.787	1.00	260
V_{NW}	2916							V =	4963
V_W	2047								
VR	0.412								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc
Interchange density, ID	1.2 int/mi
Minimum RF lane changes, LC_{RF}	1 lc/pc
Minimum FR lane changes, LC_{FR}	1 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc

Minimum weaving lane changes, LC_{MIN}	2047 lc/h
Weaving lane changes, LC_W	2183 lc/h
Non-weaving lane changes, LC_{NW}	416 lc/h
Total lane changes, LC_{ALL}	2599 lc/h
Non-weaving vehicle index, I_{NW}	254

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4963 pc/h
Weaving segment capacity, c_w	4933 veh/h
Weaving segment v/c ratio	0.927
Weaving segment density, D	47.3 pc/mi/ln
Level of Service, LOS	E

Weaving intensity factor, W	0.619
Weaving segment speed, S	35.0 mph
Average weaving speed, S_W	39.7 mph
Average non-weaving speed, S_{NW}	32.3 mph
Maximum weaving length, L_{MAX}	6821 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4055

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4210 - Rivers to I-26 WB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	725ft
Freeway free-flow speed, FFS	55 mph

Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1867	0.90	15	0	1.5	1.2	0.930	1.00	2230
V_{RF}	290	0.90	15	0	1.5	1.2	0.930	1.00	346
V_{FR}	1389	0.90	39	0	1.5	1.2	0.837	1.00	1844
V_{RR}	216	0.90	39	0	1.5	1.2	0.837	1.00	287
V_{NW}	2517							V =	4707
V_W	2190								
VR	0.465								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2190 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	2326 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	334 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2660 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	219

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4707 pc/h	Weaving intensity factor, W	0.630
Weaving segment capacity, c_w	4798 veh/h	Weaving segment speed, S	34.9 mph
Weaving segment v/c ratio	0.913	Average weaving speed, S_W	39.5 mph
Weaving segment density, D	44.9 pc/mi/ln	Average non-weaving speed, S_{NW}	31.7 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	7423 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4056

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4215-I-26 WB Off to I-26 WB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2556	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	17	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.922

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ 1541   pc/h/ln

S	55.0	mph
D = v_p / S	28.0	pc/mi/ln
LOS	D	

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4057

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	AJR		Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins		From/To	4215-I-26 WB Off to I-26 WB On
Date Performed	7/25/2014		Jurisdiction	
Analysis Time Period	PM Peak		Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2157	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	15	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.930

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1288	pc/h/ln
S	55.0	mph
D = v_p / S	23.4	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes   S   - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS   - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4058

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency/Company	Atkins	Weaving Segment Location	4220 - I-26 WB to I-26 EB C-D
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	550ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2009	0.90	17	0	1.5	1.2	0.922	1.00	2422
V_{RF}	275	0.90	7	0	1.5	1.2	0.966	1.00	316
V_{FR}	547	0.90	8	0	1.5	1.2	0.962	1.00	632
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	2422							V =	3370
V_W	948								
VR	0.281								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	948 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1052 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	219 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1271 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	160

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3370 pc/h	Weaving intensity factor, W	0.438
Weaving segment capacity, c_w	5198 veh/h	Weaving segment speed, S	42.8 mph
Weaving segment v/c ratio	0.598	Average weaving speed, S_W	42.8 mph
Weaving segment density, D	26.2 pc/mi/ln	Average non-weaving speed, S_{NW}	42.8 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5384 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4059

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		**Site Information**	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency/Company	Atkins	Weaving Segment Location	4220 - I-26 WB to I-26 EB C-D
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	550ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1675	0.90	15	0	1.5	1.2	0.930	1.00	2001
V_{RF}	338	0.90	5	0	1.5	1.2	0.976	1.00	385
V_{FR}	482	0.90	8	0	1.5	1.2	0.962	1.00	557
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	2001							V =	2943
V_W	942								
VR	0.320								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	942 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1046 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	133 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1179 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	132

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2943 pc/h	Weaving intensity factor, W	0.412
Weaving segment capacity, c_w	5157 veh/h	Weaving segment speed, S	43.4 mph
Weaving segment v/c ratio	0.531	Average weaving speed, S_W	43.3 mph
Weaving segment density, D	22.6 pc/mi/ln	Average non-weaving speed, S_{NW}	43.5 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5800 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4060

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	I-526 WB
From/To	4225-I-26 EB CD Off to On
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2284	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	0.90	
%Trucks and Buses, P_T	17	
%RVs, P_R	0	
General Terrain:	Level	
Grade % Length	mi	
Up/Down %		

Calculate Flow Adjustments

f_p	1.00
E_T	1.5

E_R	1.2
$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.922

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1377	pc/h/ln
S	55.0	mph
D = v_p / S	25.0	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010™ Version 6.41   Generated: 12/9/2014   10:16 AM

F-4061

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4225-I-26 EB CD Off to On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description	*Navy Base ICTF*

☑ Oper.(LOS)	☐ Des.(N)	☐ Planning Data

Flow Inputs

Volume, V	*2013*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs | ### Calc Speed Adj and FFS

Lane Width		ft		
Rt-Side Lat. Clearance		ft	f_{LW}	mph
Number of Lanes, N	*2*		f_{LC}	mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment	mph
FFS (measured)	*55.0*	mph	FFS *55.0*	mph
Base free-flow Speed, BFFS		mph		

LOS and Performance Measures | ### Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) = *1202* pc/h/ln

S	*55.0*	mph
D = v_p / S	*21.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) = pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010™ Version 6.41   Generated: 12/9/2014   10:16 AM

F-4062

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency/Company	Atkins	Weaving Segment Location	4230-I-26EBCD to International
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	3135ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1533	0.90	10	0	1.5	1.2	0.952	1.00	1789
V_{RF}	1491	0.90	20	0	1.5	1.2	0.909	1.00	1822
V_{FR}	751	0.90	12	0	1.5	1.2	0.943	1.00	885
V_{RR}	730	0.90	20	0	1.5	1.2	0.909	1.00	892
V_{NW}	2681							V =	5388
V_W	2707								
VR	0.502								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	534

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5388 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4549 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.128	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7855 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4063

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency/Company	Atkins	Weaving Segment Location	4230-I-26EBCD to International
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	3135ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1120	0.90	9	0	1.5	1.2	0.957	1.00	1300
V_{RF}	991	0.90	21	0	1.5	1.2	0.905	1.00	1217
V_{FR}	893	0.90	9	0	1.5	1.2	0.957	1.00	1037
V_{RR}	790	0.90	21	0	1.5	1.2	0.905	1.00	970
V_{NW}	2270							V =	4524
V_W	2254								
VR	0.498								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2254 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	2579 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1589 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	4168 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	712

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4524 pc/h	Weaving intensity factor, W	0.283
Weaving segment capacity, c_w	4610 veh/h	Weaving segment speed, S	42.2 mph
Weaving segment v/c ratio	0.939	Average weaving speed, S_W	50.1 mph
Weaving segment density, D	35.7 pc/mi/ln	Average non-weaving speed, S_{NW}	36.5 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	7806 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4064

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4235-Interna Off to Interna On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3024	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	10	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length mi		
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = $1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ 0.952	

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1764   pc/h/ln

S   59.5   mph

D = v_p / S   29.6   pc/mi/ln

LOS   D

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume

S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-4065

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	I-526 WB
From/To	4235-Interna Off to Interna On
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2111	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	0.90	
%Trucks and Buses, P_T	9	
%RVs, P_R	0	
General Terrain:	Level	
Grade % Length	mi	
Up/Down %		

Calculate Flow Adjustments

f_p	1.00
E_T	1.5

E_R	1.2
$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.957

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1226	pc/h/ln
S	60.0	mph
D = v_p / S	20.4	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4066

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4240-WB On from International
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A	875	
Deceleration Lane Length L_D		
Freeway Volume, V_F	3024	
Ramp Volume, V_R	419	
Freeway Free-Flow Speed, S_{FF}	60.0	
Ramp Free-Flow Speed, S_{FR}	45.0	

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3024	0.90	Level	10	0	0.952	1.00	3528
Ramp	419	0.90	Level	21	0	0.905	1.00	514
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | ### Estimation of v_{12} (Diverge)

Merge Areas

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   3528   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	4042	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4042	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 \, v_R + 0.0078 \, V_{12} - 0.00627 \, L_A$$

D_R =   31.3 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 \, V_{12} - 0.009 \, L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.464 (Exibit 13-11)

S_R =   51.6 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   51.6 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4067

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4240-WB On from International
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A	875	
Deceleration Lane Length L_D		
Freeway Volume, V_F	2111	
Ramp Volume, V_R	625	
Freeway Free-Flow Speed, S_{FF}	60.0	
Ramp Free-Flow Speed, S_{FR}	45.0	

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2111	0.90	Level	9	0	0.957	1.00	2451
Ramp	625	0.90	Level	12	0	0.943	1.00	736
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 2451 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No	Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	3187	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3187	Exhibit 13-8	4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge: $D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   24.5 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Diverge: $D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = 0.337 (Exibit 13-11)	D_s = (Exhibit 13-12)
S_R = 53.9 mph (Exhibit 13-11)	S_R = mph (Exhibit 13-12)
S_0 = N/A mph (Exhibit 13-11)	S_0 = mph (Exhibit 13-12)
S = 53.9 mph (Exhibit 13-13)	S = mph (Exhibit 13-13)

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F-4068

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency/Company	Atkins	Weaving Segment Location	4250-Montague to Dorchester
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	950ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2710	0.90	9	0	1.5	1.2	0.957	1.00	3147
V_{RF}	434	0.90	9	0	1.5	1.2	0.957	1.00	504
V_{FR}	733	0.90	14	0	1.5	1.2	0.935	1.00	871
V_{RR}	117	0.90	14	0	1.5	1.2	0.935	1.00	139
V_{NW}	3286							V =	4661
V_W	1375								
VR	0.295								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1375 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1531 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	614 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2145 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	312

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4661 pc/h	Weaving intensity factor, W	0.430
Weaving segment capacity, c_w	5598 veh/h	Weaving segment speed, S	43.7 mph
Weaving segment v/c ratio	0.797	Average weaving speed, S_W	46.5 mph
Weaving segment density, D	35.5 pc/mi/ln	Average non-weaving speed, S_{NW}	42.6 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5530 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4069

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency/Company	Atkins	Weaving Segment Location	4250-Montague to Dorchester
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	950ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2216	0.90	8	0	1.5	1.2	0.962	1.00	2561
V_{RF}	602	0.90	8	0	1.5	1.2	0.962	1.00	696
V_{FR}	520	0.90	16	0	1.5	1.2	0.926	1.00	624
V_{RR}	142	0.90	16	0	1.5	1.2	0.926	1.00	170
V_{NW}	2731							V =	4051
V_W	1320								
VR	0.326								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1320 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1476 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	500 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1976 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	259

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4051 pc/h	Weaving intensity factor, W	0.403
Weaving segment capacity, c_w	5550 veh/h	Weaving segment speed, S	45.0 mph
Weaving segment v/c ratio	0.702	Average weaving speed, S_W	47.1 mph
Weaving segment density, D	30.0 pc/mi/ln	Average non-weaving speed, S_{NW}	44.0 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5863 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

F-4070

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR	
Agency or Company	Atkins	
Date Performed	7/25/2014	
Analysis Time Period	AM Peak	

Site Information

Highway/Direction of Travel	I-526 WB
From/To	4255-Dorches Off to Dorches On
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3144	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	9	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.957

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1825	pc/h/ln
S	59.1	mph
D = v_p / S	30.9	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4071

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4255-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2818	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	8	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1628   pc/h/ln

S   60.0   mph

D = v_p / S   27.1   pc/mi/ln

LOS   D

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4072

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency/Company	Atkins	Weaving Segment Location	4260-Dorchester to Leeds
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1750ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2318	0.90	9	0	1.5	1.2	0.957	1.00	2691
V_{RF}	464	0.90	17	0	1.5	1.2	0.922	1.00	559
V_{FR}	826	0.90	9	0	1.5	1.2	0.957	1.00	959
V_{RR}	166	0.90	17	0	1.5	1.2	0.922	1.00	200
V_{NW}	2891							V =	4409
V_W	1518								
VR	0.344								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1518 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1751 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	966 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2717 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	506

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4409 pc/h	Weaving intensity factor, W	0.320
Weaving segment capacity, c_w	5656 veh/h	Weaving segment speed, S	44.2 mph
Weaving segment v/c ratio	0.746	Average weaving speed, S_W	49.1 mph
Weaving segment density, D	33.2 pc/mi/ln	Average non-weaving speed, S_{NW}	42.0 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	6064 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4073

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency/Company	Atkins	Weaving Segment Location	4260-Dorchester to Leeds
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1750ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2561	0.90	7	0	1.5	1.2	0.966	1.00	2945
V_{RF}	486	0.90	17	0	1.5	1.2	0.922	1.00	586
V_{FR}	257	0.90	7	0	1.5	1.2	0.966	1.00	296
V_{RR}	49	0.90	17	0	1.5	1.2	0.922	1.00	59
V_{NW}	3004							V =	3886
V_W	882								
VR	0.227								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	882 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1115 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	990 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2105 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	526

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3886 pc/h	Weaving intensity factor, W	0.261
Weaving segment capacity, c_w	5988 veh/h	Weaving segment speed, S	48.1 mph
Weaving segment v/c ratio	0.627	Average weaving speed, S_W	50.7 mph
Weaving segment density, D	26.9 pc/mi/ln	Average non-weaving speed, S_{NW}	47.4 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4814 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4074

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4265-Leeds Off to Leeds On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2782	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	10	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length		mi
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.952

Speed Inputs | ### Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures | ### Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1623   pc/h/ln

S	60.0	mph
D = v_p / S	27.1	pc/mi/ln
LOS	D	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4075

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4265-Leeds Off to Leeds On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3047	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	9	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length		mi
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ 0.957	

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1769	pc/h/ln
S	59.5	mph
D = v_p / S	29.7	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4076

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4270-WB On from Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	825
Deceleration Lane Length L_D	
Freeway Volume, V_F	2782
Ramp Volume, V_R	222
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2782	0.90	Level	10	0	0.952	1.00	3246
Ramp	222	0.90	Level	19	0	0.913	1.00	270
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   3246   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3516	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	3516	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   27.6 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.378 (Exibit 13-11)

S_R =   53.2 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   53.2 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4077

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information
Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4270-WB On from Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A	825	
Deceleration Lane Length L_D		
Freeway Volume, V_F	3047	
Ramp Volume, V_R	696	
Freeway Free-Flow Speed, S_{FF}	60.0	
Ramp Free-Flow Speed, S_{FR}	45.0	

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3047	0.90	Level	9	0	0.957	1.00	3538
Ramp	696	0.90	Level	5	0	0.976	1.00	793
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)
Estimation of v_{12} (Diverge)

Merge Areas

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   3538   pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	4331	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4331	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   33.7 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.543 (Exibit 13-11)

S_R =   50.2 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   50.2 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4078

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4280-Leeds to Paul Cantrell*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description	*Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*3004*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*10*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R		*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*	

Speed Inputs

				Calc Speed Adj and FFS		
Lane Width		ft				
Rt-Side Lat. Clearance		ft		f_{LW}		mph
Number of Lanes, N	*2*			f_{LC}		mph
Total Ramp Density, TRD		ramps/mi		TRD Adjustment		mph
FFS (measured)	*60.0*	mph		FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph				

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   *1752*   pc/h/ln

S	*59.6*	mph
D = v_p / S	*29.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4079

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4280-Leeds to Paul Cantrell
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3743	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	9	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length		mi
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ 0.957	

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) 2173 pc/h/ln

S   54.0 mph

D = v_p / S   40.2 pc/mi/ln

LOS   E

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS   - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4080

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4290-WB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	825
Freeway Volume, V_F	3004
Ramp Volume, V_R	1238
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3004	0.90	Level	10	0	0.952	1.00	3505
Ramp	1238	0.90	Level	28	0	0.877	1.00	1568
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} | ### *Estimation of v_{12}*

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3505 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | ### *Capacity Checks*

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	3505	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1937	Exhibit 13-8	4600	No
V_R	1568	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | ### *Flow Entering Diverge Influence Area*

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	3505	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) | ### *Level of Service Determination (if not F)*

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 27.0 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = C (Exhibit 13-2)

Speed Determination | ### *Speed Determination*

Merge	Diverge
M_S = (Exibit 13-11)	D_s = 0.439 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 52.1 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = N/A mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 52.1 mph (Exhibit 13-13)

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F-4081

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4290-WB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			
☐ Yes	☐ On		
☑ No	☐ Off		
L_{up} =	ft		
V_u =	veh/h		

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	825
Freeway Volume, V_F	3743
Ramp Volume, V_R	1987
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp			
☐ Yes	☐ On		
☑ No	☐ Off		
L_{down} =	ft		
V_D =	veh/h		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3743	0.90	Level	9	0	0.957	1.00	4346
Ramp	1987	0.90	Level	15	0	0.930	1.00	2373
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation   (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   1.000 using Equation (Exhibit 13-7)
V_{12} =   4346 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge:

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Diverge:

	Actual	Capacity		LOS F?
V_F	4346	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1973	Exhibit 13-8	4600	No
V_R	2373	Exhibit 13-10	2100	Yes

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Merge:

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Diverge:

	Actual	Max Desirable		Violation?
V_{12}	4346	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge:

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Diverge:

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   34.2 (pc/mi/ln)
LOS =   F (Exhibit 13-2)

Speed Determination

Merge:

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

Diverge:

D_s =   0.512 (Exhibit 13-12)
S_R =   50.8 mph (Exhibit 13-12)
S_0 =   N/A mph (Exhibit 13-12)
S =   50.8 mph (Exhibit 13-13)

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F-4082

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4300-WB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp
☐ Yes   ☐ On
☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	525
Freeway Volume, V_F	1766
Ramp Volume, V_R	665
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp
☐ Yes   ☐ On
☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1766	0.90	Level	10	0	0.952	1.00	2060
Ramp	665	0.90	Level	5	0	0.976	1.00	757
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation   (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   1.000 using Equation (Exhibit 13-7)
V_{12} =   2060 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	2060	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1303	Exhibit 13-8	4600	No
V_R	757	Exhibit 13-10	1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	2060	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   17.2 (pc/mi/ln)
LOS =   B (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.626 (Exhibit 13-12)
S_R =   48.7 mph (Exhibit 13-12)
S_0 =   N/A mph (Exhibit 13-12)
S =   48.7 mph (Exhibit 13-13)

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F-4083

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4300-WB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp				Downstream Adj Ramp	
☐ Yes	☐ On	Freeway Number of Lanes, N	2	☐ Yes	☐ On
		Ramp Number of Lanes, N	1		
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
		Deceleration Lane Length L_D	525		
L_{up} = ft		Freeway Volume, V_F	1756	L_{down} = ft	
		Ramp Volume, V_R	708		
V_u = veh/h		Freeway Free-Flow Speed, S_{FF}	60.0	V_D = veh/h	
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1756	0.90	Level	9	0	0.957	1.00	2039
Ramp	708	0.90	Level	4	0	0.980	1.00	802
UpStream								
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation   (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   1.000 using Equation (Exhibit 13-7)
V_{12} =   2039 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	2039	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1237	Exhibit 13-8	4600	No
V_R	802	Exhibit 13-10	1900	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	2039	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   17.1 (pc/mi/ln)
LOS =   B (Exhibit 13-2)

Speed Determination

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

D_s =   0.630 (Exhibit 13-12)
S_R =   48.7 mph (Exhibit 13-12)
S_0 =   N/A mph (Exhibit 13-12)
S =   48.7 mph (Exhibit 13-13)

F-4084

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4305-PaulCEB Off to PaulCEB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*1101*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*10*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) = *642* pc/h/ln

S = *60.0* mph

D = v_p / S = *10.7* pc/mi/ln

LOS = *A*

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) = pc/h/ln

S = mph

D = v_p / S = pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4085

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-526 WB
Agency or Company	Atkins	From/To	4305-PaulCEB Off to PaulCEB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1048	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	9	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.957

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft			
Number of Lanes, N	2		f_{LW}		mph
Total Ramp Density, TRD		ramps/mi	f_{LC}		mph
FFS (measured)	60.0	mph	TRD Adjustment		mph
Base free-flow Speed, BFFS		mph	FFS	60.0	mph

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   608   pc/h/ln

S   60.0   mph

D = v_p / S   10.1   pc/mi/ln

LOS   A

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S   - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS   - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4086

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4310-WB On from PaulCantrellEB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	700
Deceleration Lane Length L_D	
Freeway Volume, V_F	1101
Ramp Volume, V_R	268
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1101	0.90	Level	10	0	0.952	1.00	1285
Ramp	268	0.90	Level	7	0	0.966	1.00	308
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   1285   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	1593	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1593	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   13.4 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.277 (Exibit 13-11)

S_R =   55.0 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   55.0 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4087

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4310-WB On from PaulCantrellEB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	700
Deceleration Lane Length L_D	
Freeway Volume, V_F	1048
Ramp Volume, V_R	215
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1048	0.90	Level	9	0	0.957	1.00	1217
Ramp	215	0.90	Level	7	0	0.966	1.00	247
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge Areas — Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1217 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas — Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge

	Actual	Capacity	LOS F?
V_{FO}	1464	Exhibit 13-8	No

Diverge

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1464	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 12.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

Merge

M_S = 0.275 (Exibit 13-11)

S_R = 55.1 mph (Exhibit 13-11)

S_0 = N/A mph (Exhibit 13-11)

S = 55.1 mph (Exhibit 13-13)

Diverge

D_s = (Exhibit 13-12)

S_R = mph (Exhibit 13-12)

S_0 = mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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F-4088

Appendix E

Traffic Analysis Worksheets

2018 Opening Year

Build River Center Site Alternatives 5-7

US Highway 17

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2018 Build-River Center Site	Junction	From I-26 EB & WB
Analysis Time Period:	AM Peak	Segment ID	5010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,782	3,088	1,306
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,000	866	733
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.44	0.38	0.33
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2018 Build-River Center Site	Junction	From I-26 EB & WB
Analysis Time Period:	PM Peak	Segment ID	5010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,040	2,716	676
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,145	762	381
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.51	0.34	0.17
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)} \qquad \text{HCM 2010, Equation 11-3}$$

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P} \qquad \text{HCM 2010, Equation 11-2}$$

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5020-NB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	4
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	1125
Deceleration Lane Length L_D	
Freeway Volume, V_F	3088
Ramp Volume, V_R	460
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3088	0.90	Level	2	0	0.990	1.00	3465
Ramp	460	0.90	Level	10	0	0.952	1.00	537
UpStream								
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.151   using Equation (Exhibit 13-6)

V_{12} =   522   pc/h

V_3 or V_{av34} 1471   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes, V_{12a} =   1386   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge

	Actual	Capacity	LOS F?
V_{FO}	4002	Exhibit 13-8	No

Diverge

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Merge

	Actual	Max Desirable	Violation?
V_{R12}	1923	Exhibit 13-8 4600:All	No

Diverge

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   13.2 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination

Merge

M_S =   0.246 (Exhibit 13-11)

S_R =   51.8 mph (Exhibit 13-11)

S_0 =   53.1 mph (Exhibit 13-11)

S =   52.4 mph (Exhibit 13-13)

Diverge

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4092

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5020-NB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	4
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	1125
Deceleration Lane Length L_D	
Freeway Volume, V_F	2716
Ramp Volume, V_R	828
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2716	0.90	Level	2	0	0.990	1.00	3048
Ramp	828	0.90	Level	5	0	0.976	1.00	943
UpStream								
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.379   using Equation (Exhibit 13-6)

V_{12} =   1154   pc/h

V_3 or V_{av34} 947   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h?   ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2   ☑ Yes ☐ No

If Yes, V_{12a} =   1219   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h?   ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2   ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	3991	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	2162	Exhibit 13-8 4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   14.9 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination

M_S =   0.254 (Exhibit 13-11)

S_R =   51.7 mph (Exhibit 13-11)

S_0 =   53.5 mph (Exhibit 13-11)

S =   52.5 mph (Exhibit 13-13)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4093

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Freeway/Dir of Travel	US-17 NB
Junction	5030-NB On from E Bay
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	4
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	925
Deceleration Lane Length L_D	
Freeway Volume, V_F	3548
Ramp Volume, V_R	327
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3548	0.90	Level	3	0	0.985	1.00	4001
Ramp	327	0.90	Level	14	0	0.935	1.00	389
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.169   using Equation (Exhibit 13-6)

V_{12} =   677   pc/h

V_3 or V_{av34} 1662   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes, V_{12a} =   1600   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	4390	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	1989	Exhibit 13-8 4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) | Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   15.0 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination | Speed Determination

M_S =   0.266 (Exhibit 13-11)

S_R =   51.5 mph (Exhibit 13-11)

S_0 =   52.5 mph (Exhibit 13-11)

S =   52.0 mph (Exhibit 13-13)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4094

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Freeway/Dir of Travel	US-17 NB
Junction	5030-NB On from E Bay
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	4
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	925
Deceleration Lane Length L_D	
Freeway Volume, V_F	3544
Ramp Volume, V_R	1143
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3544	0.90	Level	3	0	0.985	1.00	3997
Ramp	1143	0.90	Level	3	0	0.985	1.00	1289
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.057   using Equation (Exhibit 13-6)

V_{12} =   227   pc/h

V_3 or V_{av34} 1885   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☑ Yes ☐ No

If Yes, V_{12a} =   1598   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	5286	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	2887	Exhibit 13-8 4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) | Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   21.6 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination | Speed Determination

M_S =   0.308 (Exhibit 13-11)

S_R =   51.0 mph (Exhibit 13-11)

S_0 =   52.5 mph (Exhibit 13-11)

S =   51.7 mph (Exhibit 13-13)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4095

BASIC FREEWAY SEGMENTS WORKSHEET

General Information			*Site Information*		
Analyst	*AJR*		Highway/Direction of Travel	*US-17 NB*	
Agency or Company	*Atkins*		From/To	*5040-E Bay to SC-703*	
Date Performed	*7/25/2014*		Jurisdiction		
Analysis Time Period	*AM Peak*		Analysis Year	*2018 Build - River Center Site*	

Project Description	*Navy Base ICTF*

☑ Oper.(LOS)	☐ Des.(N)	☐ Planning Data

Flow Inputs

Volume, V	*3875*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length mi	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

			### Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   *1098*   pc/h/ln

S	*55.0*	mph
D = v_p / S	*20.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4096

BASIC FREEWAY SEGMENTS WORKSHEET

General Information			*Site Information*	
Analyst	*AJR*		Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*		From/To	*5040-E Bay to SC-703*
Date Performed	*7/25/2014*		Jurisdiction	
Analysis Time Period	*PM Peak*		Analysis Year	*2018 Build - River Center Site*

Project Description	*Navy Base ICTF*

☑ Oper.(LOS)	☐ Des.(N)	☐ Planning Data

Flow Inputs

Volume, V	*4687*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

			### Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) *1321* pc/h/ln

S	*55.0*	mph
D = v_p / S	*24.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4097

MAJOR DIVERGE SEGMENTS ANALYSIS
ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2018 Build-River Center Site	Junction	Off to SC-703
Analysis Time Period:	AM Peak	Segment ID	5050
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Off-Ramp	Freeway Downstream of Off-Ramp	Off-Ramp
Number of Lanes, N	4	2	2
Free-Flow Speed, FFS (mph)	55	45	40
Volume, V (veh/h)	3,875	2,822	1,053
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	2%	8%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,098	1,583	608
Capacity Flow Rate, c (pc/h/ln)	2,200	2,100	2,000
v/c ratio	0.50	0.75	0.30
Density, D_{MD} (pc/mi/ln)	19.2	27.7	10.6
LOS	B	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

F-4098

MAJOR DIVERGE SEGMENTS ANALYSIS
ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2018 Build-River Center Site	Junction	Off to SC-703
Analysis Time Period:	PM Peak	Segment ID	5050
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Off-Ramp	Freeway Downstream of Off-Ramp	Off-Ramp
Number of Lanes, N	4	2	2
Free-Flow Speed, FFS (mph)	55	45	40
Volume, V (veh/h)	4,687	3,201	1,486
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	2%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,321	1,796	846
Capacity Flow Rate, c (pc/h/ln)	2,200	2,100	2,000
v/c ratio	0.60	0.86	0.42
Density, D_{MD} (pc/mi/ln)	23.1	31.4	14.8
LOS	C	D	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2018 Build-River Center Site	Junction	Off to Bowman
Analysis Time Period:	AM Peak	Segment ID	5060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	2,156	1,489	667
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	6%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	814	852	749
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.39	0.41	0.36
Density, D_{MD} (pc/mi/ln)	14.2	14.9	13.1
LOS	B	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2018 Build-River Center Site	Junction	Off to Bowman
Analysis Time Period:	PM Peak	Segment ID	5060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	3,036	2,338	698
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	4%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,141	1,325	783
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.54	0.63	0.37
Density, D_{MD} (pc/mi/ln)	20.0	23.2	13.7
LOS	B	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)} \qquad \text{HCM 2010, Equation 11-3}$$

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P} \qquad \text{HCM 2010, Equation 11-2}$$

$$D_{MD} = \frac{0.0175*v_f}{N} \qquad \text{HCM 2010, Equation 13-26}$$

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	US-17 NB
Agency or Company	Atkins	From/To	5065-Bowman Off to Bowman On
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1489	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.971

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft			
Number of Lanes, N	2		f_{LW}		mph
Total Ramp Density, TRD		ramps/mi	f_{LC}		mph
FFS (measured)	55.0	mph	TRD Adjustment		mph
Base free-flow Speed, BFFS		mph	FFS	55.0	mph

LOS and Performance Measures / Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   852   pc/h/ln

S   55.0   mph

D = v_p / S   15.5   pc/mi/ln

LOS   B

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
DDHV - Directional design hour volume

S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-4102

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5065-Bowman Off to Bowman On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*2338*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs | Calc Speed Adj and FFS

Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures | Design (N)

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ *1325*   pc/h/ln

S	*55.0*	mph
$D = v_p / S$	*24.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S		mph
$D = v_p / S$		pc/mi/ln
Required Number of Lanes, N		

Glossary | Factor Location

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8

E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9

f_p - Page 11-18   TRD - Page 11-11

LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4103

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency/Company	Atkins	Weaving Segment Location	5070-Bowman On to I-526 WB Off
Date Performed	7/25/2014		
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	3		
Weaving segment length, L_S	825ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	45 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	797	0.90	6	0	1.5	1.2	0.971	1.00	912
V_{RF}	248	0.90	14	0	1.5	1.2	0.935	1.00	295
V_{FR}	692	0.90	6	0	1.5	1.2	0.971	1.00	792
V_{RR}	215	0.90	14	0	1.5	1.2	0.935	1.00	256
V_{NW}	1168							V =	2255
V_W	1087								
VR	0.482								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1087 lc/h
Interchange density, ID	0.3 int/mi	Weaving lane changes, LC_W	1186 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	110 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1296 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	29

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2255 pc/h	Weaving intensity factor, W	0.323
Weaving segment capacity, c_w	4834 veh/h	Weaving segment speed, S	35.4 mph
Weaving segment v/c ratio	0.453	Average weaving speed, S_W	37.7 mph
Weaving segment density, D	21.2 pc/mi/ln	Average non-weaving speed, S_{NW}	33.6 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	7617 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4104

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency/Company	Atkins	Weaving Segment Location	5070-Bowman On to I-526 WB Off
Date Performed	7/25/2014		
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	3		
Weaving segment length, L_S	825ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	45 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1682	0.90	4	0	1.5	1.2	0.980	1.00	1906
V_{RF}	591	0.90	7	0	1.5	1.2	0.966	1.00	680
V_{FR}	656	0.90	4	0	1.5	1.2	0.980	1.00	743
V_{RR}	230	0.90	7	0	1.5	1.2	0.966	1.00	265
V_{NW}	2171							V =	3594
V_W	1423								
VR	0.396								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1423 lc/h
Interchange density, ID	0.3 int/mi	Weaving lane changes, LC_W	1522 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	317 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1839 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	54

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3594 pc/h	Weaving intensity factor, W	0.425
Weaving segment capacity, c_w	5309 veh/h	Weaving segment speed, S	31.4 mph
Weaving segment v/c ratio	0.664	Average weaving speed, S_W	36.0 mph
Weaving segment density, D	38.1 pc/mi/ln	Average non-weaving speed, S_{NW}	29.0 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6636 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4105

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	US-17 NB
Agency or Company	Atkins	From/To	5075-526 WB Off to 526 WB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)　　　　　☐ Des.(N)　　　　　☐ Planning Data

Flow Inputs

Volume, V	1045	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ 0.971	

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   598   pc/h/ln

S	55.0	mph
D = v_p / S	10.9	pc/mi/ln
LOS	A	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4106

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	US-17 NB
Agency or Company	Atkins	From/To	5075-526 WB Off to 526 WB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2273	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	4	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.980

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   **1288**   pc/h/ln

S	55.0	mph
D = v_p / S	23.4	pc/mi/ln
LOS	C	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4107

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2018 Build-River Center Site	Junction	From I-526 WB
Analysis Time Period:	AM Peak	Segment ID	5080
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	1,045	1,350	305
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	6%	13%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.94
Demand Flow Rate, v_p (pc/h/ln)	598	515	361
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.28	0.25	0.17
Density, D_{MD} (pc/mi/ln)	10.5	9.0	6.3
LOS	B	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF \cdot N \cdot f_{HV} \cdot f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175 \cdot v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2018 Build-River Center Site	Junction	From I-526 WB
Analysis Time Period:	PM Peak	Segment ID	5080
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	2,273	2,709	436
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	8%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,288	1,023	504
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.61	0.49	0.24
Density, D_{MD} (pc/mi/ln)	22.5	17.9	8.8
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6010-Off to I-526 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp		Freeway/Ramp Inputs		Downstream Adj Ramp	
☐ Yes ☐ On		Freeway Number of Lanes, N	2	☐ Yes ☐ On	
☑ No ☐ Off		Ramp Number of Lanes, N	1	☑ No ☐ Off	
		Acceleration Lane Length, L_A			
L_{up} = ft		Deceleration Lane Length L_D	450	L_{down} = ft	
		Freeway Volume, V_F	2173		
V_u = veh/h		Ramp Volume, V_R	359	V_D = veh/h	
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2173	0.90	Level	6	0	0.971	1.00	2487
Ramp	359	0.90	Level	3	0	0.985	1.00	405
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} | Estimation of v_{12}

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   1.000   using Equation (Exhibit 13-7)
V_{12} =   2487 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

Merge:

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Diverge:

	Actual	Capacity		LOS F?
V_F	2487	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	2082	Exhibit 13-8	4500	No
V_R	405	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

Merge:

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Diverge:

	Actual	Max Desirable		Violation?
V_{12}	2487	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) | Level of Service Determination (if not F)

Merge:

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Diverge:

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   21.6 (pc/mi/ln)
LOS =   C (Exhibit 13-2)

Speed Determination | Speed Determination

Merge:

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

Diverge:

D_S =   0.334 (Exhibit 13-12)
S_R =   50.7 mph (Exhibit 13-12)
S_0 =   N/A mph (Exhibit 13-12)
S =   50.7 mph (Exhibit 13-13)

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F-4110

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6010-Off to I-526 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On
☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	450
Freeway Volume, V_F	1716
Ramp Volume, V_R	290
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On
☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1716	0.90	Level	4	0	0.980	1.00	1945
Ramp	290	0.90	Level	3	0	0.985	1.00	327
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} =   pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   1.000 using Equation (Exhibit 13-7)
V_{12} =   1945 pc/h
V_3 or V_{av34} =   0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	1945	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1618	Exhibit 13-8	4500	No
V_R	327	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	1945	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   16.9 (pc/mi/ln)
LOS =   B (Exhibit 13-2)

Speed Determination — Merge

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

Speed Determination — Diverge

D_s =   0.327 (Exhibit 13-12)
S_R =   50.7 mph (Exhibit 13-12)
S_0 =   N/A mph (Exhibit 13-12)
S =   50.7 mph (Exhibit 13-13)

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F-4111

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*	
Agency or Company	*Atkins*	
Date Performed	*7/25/2014*	
Analysis Time Period	*AM Peak*	

Site Information

Highway/Direction of Travel	*US 17 SB*
From/To	*6015-526 EB Off to 526 EB On*
Jurisdiction	
Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*1814*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*6*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1038	pc/h/ln
S	*55.0*	mph
D = v_p / S	*18.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4112

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Project Description   Navy Base ICTF

Site Information

Highway/Direction of Travel	US-17 SB
From/To	6015-526 EB Off to 526 EB On
Jurisdiction	
Analysis Year	2018 Build - River Center Site

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1426	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	4	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.980

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	808	pc/h/ln
S	55.0	mph
D = v_p / S	14.7	pc/mi/ln
LOS	B	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

HCS 2010™   Version 6.41   Generated: 12/9/2014   11:05 AM

F-4113

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency/Company	Atkins	Weaving Segment Location	6020-I-526 EB On to Bowman Off
Date Performed	7/25/2014		
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	4		
Weaving segment length, L_S	650ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	45 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1425	0.90	6	0	1.5	1.2	0.971	1.00	1631
V_{RF}	832	0.90	13	0	1.5	1.2	0.939	1.00	985
V_{FR}	389	0.90	12	0	1.5	1.2	0.943	1.00	458
V_{RR}	228	0.90	13	0	1.5	1.2	0.939	1.00	270
V_{NW}	1901							V =	3344
V_W	1443								
VR	0.432								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	985 lc/h
Interchange density, ID	0.3 int/mi	Weaving lane changes, LC_W	1129 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	1129 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	37

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3344 pc/h	Weaving intensity factor, W	0.349
Weaving segment capacity, c_w	7305 veh/h	Weaving segment speed, S	35.3 mph
Weaving segment v/c ratio	0.444	Average weaving speed, S_W	37.2 mph
Weaving segment density, D	23.7 pc/mi/ln	Average non-weaving speed, S_{NW}	33.9 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	5471 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4114

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	US-17 SB
Weaving Segment Location	6020-I-526 EB On to Bowman Off
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	650ft
Freeway free-flow speed, FFS	45 mph

Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1052	0.90	4	0	1.5	1.2	0.980	1.00	1192
V_{RF}	767	0.90	11	0	1.5	1.2	0.948	1.00	899
V_{FR}	374	0.90	10	0	1.5	1.2	0.952	1.00	436
V_{RR}	272	0.90	11	0	1.5	1.2	0.948	1.00	319
V_{NW}	1511							V =	2846
V_W	1335								
VR	0.469								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	899 lc/h
Interchange density, ID	0.3 int/mi	Weaving lane changes, LC_W	1043 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	1043 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	29

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2846 pc/h	Weaving intensity factor, W	0.328
Weaving segment capacity, c_w	7247 veh/h	Weaving segment speed, S	36.2 mph
Weaving segment v/c ratio	0.385	Average weaving speed, S_W	37.6 mph
Weaving segment density, D	19.6 pc/mi/ln	Average non-weaving speed, S_{NW}	35.1 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	5901 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4115

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR	
Agency or Company	Atkins	
Date Performed	7/25/2014	
Analysis Time Period	AM Peak	

Site Information

Highway/Direction of Travel	US-17 SB
From/To	6025-Bowman Off to Bowman On
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2257	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00		E_R	1.2
E_T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.971

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1292	pc/h/ln
S	55.0	mph
D = v_p / S	23.5	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4116

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Highway/Direction of Travel	US-17 SB
Agency or Company	Atkins	From/To	6025-Bowman Off to Bowman On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1819	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	4	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.980

Speed Inputs | ### Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures | ### Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1031   pc/h/ln

S   55.0   mph

D = v_p / S   18.7   pc/mi/ln

LOS   C

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary | ### Factor Location

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4117

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6030-SB On from Bowman
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	900
Deceleration Lane Length L_D	
Freeway Volume, V_F	2257
Ramp Volume, V_R	713
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2257	0.90	Level	6	0	0.971	1.00	2583
Ramp	713	0.90	Level	2	0	0.990	1.00	800
UpStream								
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   1.000   using Equation (Exhibit 13-6)
V_{12} =   2583   pc/h
V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   using Equation (Exhibit 13-7)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	3383	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3383	Exhibit 13-8	4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   25.9 (pc/mi/ln)
LOS =   C (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Speed Determination

M_S =   0.355 (Exibit 13-11)
S_R =   50.4 mph (Exhibit 13-11)
S_0 =   N/A mph (Exhibit 13-11)
S =   50.4 mph (Exhibit 13-13)

D_s =   (Exhibit 13-12)
S_R =   mph (Exhibit 13-12)
S_0 =   mph (Exhibit 13-12)
S =   mph (Exhibit 13-13)

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F-4118

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6030-SB On from Bowman
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			
☐ Yes	☐ On		
☑ No	☐ Off		
L_{up} =	ft		
V_u =	veh/h		

Freeway Number of Lanes, N		2
Ramp Number of Lanes, N		1
Acceleration Lane Length, L_A		900
Deceleration Lane Length L_D		
Freeway Volume, V_F		1819
Ramp Volume, V_R		727
Freeway Free-Flow Speed, S_{FF}		55.0
Ramp Free-Flow Speed, S_{FR}		45.0

Downstream Adj Ramp	
☐ Yes	☐ On
☑ No	☐ Off
L_{down} =	ft
V_D =	veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1819	0.90	Level	4	0	0.980	1.00	2062
Ramp	727	0.90	Level	2	0	0.990	1.00	816
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 2062 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	2878	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2878	Exhibit 13-8	4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge:

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = 21.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Diverge:

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

Merge:

M_S = 0.309 (Exibit 13-11)

S_R = 51.0 mph (Exhibit 13-11)

S_0 = N/A mph (Exhibit 13-11)

S = 51.0 mph (Exhibit 13-13)

Diverge:

D_s = (Exhibit 13-12)

S_R = mph (Exhibit 13-12)

S_0 = mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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F-4119

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6035-SB On from Wingo Way
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description	Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	875
Deceleration Lane Length L_D	
Freeway Volume, V_F	2284
Ramp Volume, V_R	779
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2284	0.90	Level	3	0	0.985	1.00	2576
Ramp	779	0.90	Level	2	0	0.990	1.00	874
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   2576   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3450	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3450	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   26.5 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.365 (Exibit 13-11)

S_R =   50.3 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   50.3 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4120

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information   Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6035-SB On from Wingo Way
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	875
Deceleration Lane Length L_D	
Freeway Volume, V_F	2228
Ramp Volume, V_R	794
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2228	0.90	Level	2	0	0.990	1.00	2500
Ramp	794	0.90	Level	2	0	0.990	1.00	891
UpStream								
DownStream								

Merge Areas   Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000   using Equation (Exhibit 13-6)

V_{12} =   2500   pc/h

V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3391	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3391	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$$

D_R =   26.0 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.358 (Exibit 13-11)

S_R =   50.3 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   50.3 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4121

MAJOR MERGE SEGMENTS ANALYSIS
ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 SB
Analysis Year	2018 Build-River Center Site	Junction	From SC-703
Analysis Time Period:	AM Peak	Segment ID	6040
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	40
Volume, V (veh/h)	3,063	4,368	1,305
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	4%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,719	1,238	747
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,000
v/c ratio	0.76	0.55	0.37
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 SB
Analysis Year	2018 Build-River Center Site	Junction	From SC-703
Analysis Time Period:	PM Peak	Segment ID	6040
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	40
Volume, V (veh/h)	3,022	4,186	1,164
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	3%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,696	1,180	666
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,000
v/c ratio	0.75	0.52	0.33
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*
Agency or Company	*Atkins*
Date Performed	*7/25/2014*
Analysis Time Period	*AM Peak*

Site Information

Highway/Direction of Travel	*US-17 SB*
From/To	*6045-SC-703 to E Bay*
Jurisdiction	
Analysis Year	*2018 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*4368*	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	*0.90*	
%Trucks and Buses, P_T	*4*	
%RVs, P_R	*0*	
General Terrain:	*Level*	
Grade % Length	*mi*	
Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*
E_T	*1.5*

E_R	*1.2*
f_{HV} = $1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1238*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*22.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4124

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	US-17 SB
From/To	6045-SC-703 to E Bay
Jurisdiction	
Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	4186	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	3	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R		1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$		0.985

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	4	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1180	pc/h/ln
S	55.0	mph
D = v_p / S	21.5	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4125

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6050-Off to Morrison
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	4
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	4368
Ramp Volume, V_R	558
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} =   885 ft

V_D =   481 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4368	0.90	Level	4	0	0.980	1.00	4950
Ramp	558	0.90	Level	11	0	0.948	1.00	654
UpStream								
DownStream	481	0.90	Level	7	0	0.966	1.00	553

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge Areas

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   0.436 using Equation (Exhibit 13-7)

V_{12} =   2527 pc/h

V_3 or V_{av34} 1211 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Diverge

	Actual	Capacity		LOS F?
V_F	4950	Exhibit 13-8	9000	No
$V_{FO} = V_F - V_R$	4296	Exhibit 13-8	9000	No
V_R	654	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Merge

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Diverge

	Actual	Max Desirable		Violation?
V_{12}	2527	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   24.2 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Speed Determination

Merge

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Diverge

D_s =   0.357 (Exhibit 13-12)

S_R =   50.4 mph (Exhibit 13-12)

S_0 =   59.5 mph (Exhibit 13-12)

S =   54.5 mph (Exhibit 13-13)

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F-4126

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6050-Off to Morrison
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	4	☑ Yes ☐ On	
☑ No ☐ Off	Ramp Number of Lanes, N	1	☐ No ☑ Off	
	Acceleration Lane Length, L_A			
L_{up} = ft	Deceleration Lane Length L_D	200	L_{down} = 885 ft	
	Freeway Volume, V_F	4186		
V_u = veh/h	Ramp Volume, V_R	474	V_D = 348 veh/h	
	Freeway Free-Flow Speed, S_{FF}	55.0		
	Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4186	0.90	Level	3	0	0.985	1.00	4721
Ramp	474	0.90	Level	11	0	0.948	1.00	556
UpStream								
DownStream	348	0.90	Level	8	0	0.962	1.00	402

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 0.436 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 2372 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 1174 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

	Actual	Capacity		LOS F?
V_F	4721	Exhibit 13-8	9000	No
$V_{FO} = V_F - V_R$	4165	Exhibit 13-8	9000	No
V_R	556	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable		Violation?
V_{12}	2372	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 22.9 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = C (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = (Exibit 13-11)	D_s = 0.348 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 50.5 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = 59.7 mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 54.7 mph (Exhibit 13-13)

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F-4127

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2018 Build-River Center Site	Junction	Off to Meeting
Analysis Time Period:	AM Peak	Segment ID	6060
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,810	3,329	481
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	2%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,074	1,245	553
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.48	0.55	0.26
Density, D_{MD} (pc/mi/ln)	18.8	21.8	9.7
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2018 Build-River Center Site	Junction	Off to Meeting
Analysis Time Period:	PM Peak	Segment ID	6060
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,712	3,364	348
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	2%	8%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,047	1,258	402
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.47	0.56	0.19
Density, D_{MD} (pc/mi/ln)	18.3	22.0	7.0
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS
ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2018 Build-River Center Site	Junction	Off to I-26 WB
Analysis Time Period:	AM Peak	Segment ID	6070
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,329	2,198	1,131
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,245	1,233	1,276
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.55	0.55	0.58
Density, D_{MD} (pc/mi/ln)	21.8	21.6	22.3
LOS	C	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2018 Build-River Center Site	Junction	Off to I-26 WB
Analysis Time Period:	PM Peak	Segment ID	6070
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,364	2,229	1,135
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,258	1,251	1,274
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.56	0.56	0.58
Density, D_{MD} (pc/mi/ln)	22.0	21.9	22.3
LOS	C	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↑↑↑	↗	↱	↑↑	↗			↗			↗
Volume (vph)	155	2611	56	52	2223	60	0	0	76	0	0	61
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00			1.00			1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85			0.86			0.86
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (prot)	1752	5036	1568	1752	3505	1568			1611			1580
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (perm)	1752	5036	1568	1752	3505	1568			1611			1580
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	172	2901	62	58	2470	67	0	0	84	0	0	68
RTOR Reduction (vph)	0	0	8	0	0	11	0	0	54	0	0	17
Lane Group Flow (vph)	172	2901	54	58	2470	56	0	0	30	0	0	51
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	2%	2%	2%	4%	4%	4%
Turn Type	Prot	NA	Perm	Prot	NA	Perm			Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases			2			6			1			5
Actuated Green, G (s)	20.7	147.3	147.3	10.7	137.3	137.3			10.7			20.7
Effective Green, g (s)	20.7	147.3	147.3	10.7	137.3	137.3			10.7			20.7
Actuated g/C Ratio	0.12	0.87	0.87	0.06	0.81	0.81			0.06			0.12
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0			3.0			3.0
Lane Grp Cap (vph)	213	4363	1358	110	2830	1266			101			192
v/s Ratio Prot	c0.10	0.58		0.03	c0.70				0.02			0.03
v/s Ratio Perm			0.03			0.04						
v/c Ratio	0.81	0.66	0.04	0.53	0.87	0.04			0.29			0.27
Uniform Delay, d1	72.7	3.6	1.6	77.2	10.7	3.3			76.0			67.8
Progression Factor	1.00	1.00	1.00	0.75	1.89	0.02			1.00			1.00
Incremental Delay, d2	19.6	0.8	0.1	2.2	2.0	0.0			1.6			0.8
Delay (s)	92.4	4.4	1.6	60.4	22.1	0.1			77.7			68.5
Level of Service	F	A	A	E	C	A			E			E
Approach Delay (s)		9.2			22.4			77.7			68.5	
Approach LOS		A			C			E			E	

Intersection Summary				
HCM 2000 Control Delay	16.7	HCM 2000 Level of Service	B	
HCM 2000 Volume to Capacity ratio	0.86			
Actuated Cycle Length (s)	170.0	Sum of lost time (s)	12.0	
Intersection Capacity Utilization	80.0%	ICU Level of Service	D	
Analysis Period (min)	15			

c   Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↑↑↑	↗	↱	↑↑	↗			↗			↗
Volume (vph)	115	3007	79	49	2167	40	0	0	76	0	0	61
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00			1.00			1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85			0.86			0.86
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (prot)	1770	5085	1583	1770	3539	1583			1611			1580
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (perm)	1770	5085	1583	1770	3539	1583			1611			1580
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	128	3341	88	54	2408	44	0	0	84	0	0	68
RTOR Reduction (vph)	0	0	13	0	0	8	0	0	66	0	0	21
Lane Group Flow (vph)	128	3341	75	54	2408	36	0	0	19	0	0	47
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	4%	4%	4%
Turn Type	Prot	NA	Perm	Prot	NA	Perm			Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases			2			6			1			5
Actuated Green, G (s)	14.4	119.0	119.0	9.0	113.6	113.6			9.0			14.4
Effective Green, g (s)	14.4	119.0	119.0	9.0	113.6	113.6			9.0			14.4
Actuated g/C Ratio	0.10	0.85	0.85	0.06	0.81	0.81			0.06			0.10
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0			3.0			3.0
Lane Grp Cap (vph)	182	4322	1345	113	2871	1284			103			162
v/s Ratio Prot	c0.07	c0.66		0.03	c0.68				0.01			0.03
v/s Ratio Perm			0.05			0.02						
v/c Ratio	0.70	0.77	0.06	0.48	0.84	0.03			0.18			0.29
Uniform Delay, d1	60.7	4.6	1.7	63.2	7.8	2.5			62.0			58.1
Progression Factor	1.00	1.00	1.00	1.09	1.22	0.00			1.00			1.00
Incremental Delay, d2	11.6	1.4	0.1	1.6	1.6	0.0			0.8			1.0
Delay (s)	72.4	6.0	1.7	70.3	11.2	0.0			62.8			59.1
Level of Service	E	A	A	E	B	A			E			E
Approach Delay (s)		8.3			12.3			62.8			59.1	
Approach LOS		A			B			E			E	

Intersection Summary			
HCM 2000 Control Delay	11.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	140.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	77.4%	ICU Level of Service	D
Analysis Period (min)	15		

c   Critical Lane Group

F-4133

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	⬏⬏	⬆⬆⬆	⬀	⬏⬏	⬆⬆⬆	⬀	⬏	⬆⬆	⬀	⬏	⬆⬆	⬀
Volume (veh/h)	424	1927	336	344	2079	118	171	242	171	58	260	85
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1845	1845	1845	1845	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	471	2141	373	382	2310	131	190	269	190	64	289	94
Adj No. of Lanes	2	3	1	2	3	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	3	3	3	2	2	2	2	2	2
Cap, veh/h	504	2709	1010	421	2587	885	244	529	432	206	332	383
Arrive On Green	0.30	1.00	1.00	0.12	0.51	0.51	0.11	0.15	0.15	0.05	0.09	0.09
Sat Flow, veh/h	3408	5036	1568	3408	5036	1568	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	471	2141	373	382	2310	131	190	269	190	64	289	94
Grp Sat Flow(s),veh/h/ln	1704	1679	1568	1704	1679	1568	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	22.8	0.0	0.0	18.7	69.8	6.7	16.0	11.9	16.8	5.4	13.7	8.1
Cycle Q Clear(g_c), s	22.8	0.0	0.0	18.7	69.8	6.7	16.0	11.9	16.8	5.4	13.7	8.1
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	504	2709	1010	421	2587	885	244	529	432	206	332	383
V/C Ratio(X)	0.94	0.79	0.37	0.91	0.89	0.15	0.78	0.51	0.44	0.31	0.87	0.25
Avail Cap(c_a), veh/h	523	2709	1010	442	2587	885	244	529	432	211	334	383
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.70	0.70	0.70	0.31	0.31	0.31	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	58.9	0.0	0.0	73.3	37.0	17.6	59.8	66.3	50.9	64.4	75.8	51.8
Incr Delay (d2), s/veh	18.6	1.7	0.7	8.5	1.7	0.1	14.7	0.8	0.7	0.8	21.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	11.9	0.4	0.2	9.4	32.7	2.9	8.8	5.8	7.4	2.7	7.7	3.6
LnGrp Delay(d),s/veh	77.5	1.7	0.7	81.8	38.8	17.7	74.5	67.1	51.6	65.2	96.8	52.1
LnGrp LOS	E	A	A	F	D	B	E	E	D	E	F	D
Approach Vol, veh/h		2985			2823			649			447	
Approach Delay, s/veh		13.6			43.6			64.7			82.9	
Approach LOS		B			D			E			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	26.9	97.2	24.0	21.9	31.0	93.1	14.6	31.3
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	22.0	90.0	18.0	16.0	26.0	86.0	9.0	25.0
Max Q Clear Time (g_c+I1), s	20.7	2.0	18.0	15.7	24.8	71.8	7.4	18.8
Green Ext Time (p_c), s	0.2	83.8	0.0	0.1	0.2	14.0	0.0	2.4

Intersection Summary	
HCM 2010 Ctrl Delay	35.1
HCM 2010 LOS	D

F-4134

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	⌐↑↑	↑↑↑	↑	⌐↑↑	↑↑↑	↑	⌐↑	↑↑	↑	⌐	↑↑	↑
Volume (veh/h)	418	2351	314	292	1863	125	217	270	314	114	227	176
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1845	1845	1845	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	464	2612	349	324	2070	139	241	300	349	127	252	196
Adj No. of Lanes	2	3	1	2	3	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	3	3	3	2	2	2	2	2	2
Cap, veh/h	506	2652	973	341	2389	863	260	463	366	226	404	414
Arrive On Green	0.29	1.00	1.00	0.10	0.47	0.47	0.09	0.13	0.13	0.08	0.11	0.11
Sat Flow, veh/h	3442	5085	1583	3408	5036	1568	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	464	2612	349	324	2070	139	241	300	349	127	252	196
Grp Sat Flow(s),veh/h/ln	1721	1695	1583	1704	1679	1568	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	18.2	0.0	0.0	13.2	51.4	6.1	13.0	11.3	18.3	8.7	9.5	14.6
Cycle Q Clear(g_c), s	18.2	0.0	0.0	13.2	51.4	6.1	13.0	11.3	18.3	8.7	9.5	14.6
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	506	2652	973	341	2389	863	260	463	366	226	404	414
V/C Ratio(X)	0.92	0.99	0.36	0.95	0.87	0.16	0.93	0.65	0.95	0.56	0.62	0.47
Avail Cap(c_a), veh/h	541	2652	973	341	2389	863	260	463	366	230	404	414
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.55	0.55	0.55	0.41	0.41	0.41	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	48.6	0.0	0.0	62.7	32.8	15.5	54.0	57.8	53.1	49.7	59.1	43.6
Incr Delay (d2), s/veh	12.7	10.0	0.6	20.3	2.0	0.2	37.0	3.1	35.2	3.0	3.0	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.5	2.5	0.2	7.2	24.2	2.7	5.6	5.7	16.9	4.5	4.8	6.5
LnGrp Delay(d),s/veh	61.2	10.0	0.6	82.9	34.8	15.7	91.0	60.9	88.3	52.7	62.1	44.4
LnGrp LOS	E	A	A	F	C	B	F	E	F	D	E	D
Approach Vol, veh/h		3425			2533			890			575	
Approach Delay, s/veh		16.0			39.9			79.8			54.0	
Approach LOS		B			D			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.0	79.0	19.0	22.0	26.6	72.4	16.7	24.3
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	14.0	73.0	13.0	16.0	22.0	65.0	11.0	18.0
Max Q Clear Time (g_c+I1), s	15.2	2.0	15.0	16.6	20.2	53.4	10.7	20.3
Green Ext Time (p_c), s	0.0	69.1	0.0	0.0	0.3	11.6	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	34.7
HCM 2010 LOS	C

F-4135

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↟↟↟	↗	↰	↟↟↟	↗	↰	↟	↗	↰↰	↟	↗
Volume (veh/h)	237	1750	169	193	2233	261	120	190	175	181	212	188
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1845	1845	1845	1845	1845	1845	1845	1863	1863	1863
Adj Flow Rate, veh/h	263	1944	188	214	2481	290	133	211	194	201	236	209
Adj No. of Lanes	1	3	1	1	3	1	1	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	3	3	3	3	3	3	2	2	2
Cap, veh/h	264	2857	1019	237	2636	930	145	262	348	239	241	400
Arrive On Green	0.12	0.57	0.57	0.05	0.35	0.35	0.08	0.14	0.14	0.07	0.13	0.13
Sat Flow, veh/h	1757	5036	1568	1757	5036	1568	1757	1845	1568	3442	1863	1583
Grp Volume(v), veh/h	263	1944	188	214	2481	290	133	211	194	201	236	209
Grp Sat Flow(s),veh/h/ln	1757	1679	1568	1757	1679	1568	1757	1845	1568	1721	1863	1583
Q Serve(g_s), s	20.9	46.2	8.1	11.1	81.2	19.9	12.8	18.8	18.7	9.8	21.5	19.3
Cycle Q Clear(g_c), s	20.9	46.2	8.1	11.1	81.2	19.9	12.8	18.8	18.7	9.8	21.5	19.3
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	264	2857	1019	237	2636	930	145	262	348	239	241	400
V/C Ratio(X)	1.00	0.68	0.18	0.90	0.94	0.31	0.92	0.80	0.56	0.84	0.98	0.52
Avail Cap(c_a), veh/h	264	2857	1019	376	2636	930	145	262	348	243	241	400
HCM Platoon Ratio	1.00	1.00	1.00	0.67	0.67	0.67	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.58	0.58	0.58	0.67	0.67	0.67	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	62.2	25.9	11.8	39.6	52.6	24.7	77.4	70.6	58.7	78.2	73.8	54.7
Incr Delay (d2), s/veh	41.4	0.8	0.2	11.8	6.0	0.6	51.3	16.5	2.0	22.0	51.9	1.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	15.4	21.6	3.5	10.8	39.1	8.8	8.3	10.8	8.3	5.4	14.6	8.6
LnGrp Delay(d),s/veh	103.6	26.7	12.1	51.4	58.6	25.3	128.7	87.1	60.7	100.2	125.6	55.9
LnGrp LOS	F	C	B	D	E	C	F	F	E	F	F	E
Approach Vol, veh/h		2395			2985			538			646	
Approach Delay, s/veh		34.0			54.8			87.9			95.1	
Approach LOS		C			D			F			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	19.5	102.5	20.0	28.0	27.0	95.0	17.8	30.2
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	27.0	83.0	14.0	22.0	21.0	89.0	12.0	24.0
Max Q Clear Time (g_c+I1), s	13.1	48.2	14.8	23.5	22.9	83.2	11.8	20.8
Green Ext Time (p_c), s	0.5	34.0	0.0	0.0	0.0	5.8	0.0	1.4

Intersection Summary	
HCM 2010 Ctrl Delay	53.9
HCM 2010 LOS	D

F-4136

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↑	↗	↰	↑↑↑	↗	↰	↑	↗	↰↰	↑	↗
Volume (veh/h)	293	2370	116	203	1954	159	101	173	247	199	203	225
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1845	1845	1845	1845	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	326	2633	129	226	2171	177	112	192	274	221	226	250
Adj No. of Lanes	1	3	1	1	3	1	1	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	3	3	3	2	2	2	2	2	2
Cap, veh/h	327	2734	952	219	2446	874	114	226	339	246	239	441
Arrive On Green	0.15	0.54	0.54	0.06	0.33	0.33	0.06	0.12	0.12	0.07	0.13	0.13
Sat Flow, veh/h	1757	5036	1568	1757	5036	1568	1774	1863	1583	3442	1863	1583
Grp Volume(v), veh/h	326	2633	129	226	2171	177	112	192	274	221	226	250
Grp Sat Flow(s),veh/h/ln	1757	1679	1568	1757	1679	1568	1774	1863	1583	1721	1863	1583
Q Serve(g_s), s	20.9	70.1	4.9	13.0	57.2	9.9	8.8	14.1	17.0	8.9	16.8	18.0
Cycle Q Clear(g_c), s	20.9	70.1	4.9	13.0	57.2	9.9	8.8	14.1	17.0	8.9	16.8	18.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	327	2734	952	219	2446	874	114	226	339	246	239	441
V/C Ratio(X)	1.00	0.96	0.14	1.03	0.89	0.20	0.98	0.85	0.81	0.90	0.94	0.57
Avail Cap(c_a), veh/h	327	2734	952	219	2446	874	114	226	339	246	239	441
HCM Platoon Ratio	1.00	1.00	1.00	0.67	0.67	0.67	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.25	0.25	0.25	0.78	0.78	0.78	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	47.8	30.7	11.8	48.9	43.6	20.9	65.4	60.2	52.3	64.5	60.5	43.3
Incr Delay (d2), s/veh	24.3	3.5	0.1	62.6	4.2	0.4	78.4	24.9	13.5	32.1	42.7	1.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	14.8	33.3	2.1	12.3	27.5	4.4	6.8	8.9	11.3	5.3	11.5	8.5
LnGrp Delay(d),s/veh	72.1	34.2	11.8	111.6	47.8	21.3	143.8	85.2	65.7	96.6	103.2	45.0
LnGrp LOS	E	C	B	F	D	C	F	F	E	F	F	D
Approach Vol, veh/h		3088			2574			578			697	
Approach Delay, s/veh		37.2			51.6			87.3			80.2	
Approach LOS		D			D			F			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	19.0	82.0	15.0	24.0	27.0	74.0	16.0	23.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	13.0	76.0	9.0	18.0	21.0	68.0	10.0	17.0
Max Q Clear Time (g_c+I1), s	15.0	72.1	10.8	20.0	22.9	59.2	10.9	19.0
Green Ext Time (p_c), s	0.0	3.9	0.0	0.0	0.0	8.7	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	51.0
HCM 2010 LOS	D

F-4137

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑↑	↗	↖	↑↑↑	↖	↗
Volume (veh/h)	1999	107	111	2609	78	102
Number	2	12	1	6	3	18
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1827	1827	1863	1863
Adj Flow Rate, veh/h	2221	119	123	2899	87	113
Adj No. of Lanes	3	1	1	3	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	4	4	2	2
Cap, veh/h	3904	1341	253	4313	142	212
Arrive On Green	1.00	1.00	0.11	1.00	0.08	0.08
Sat Flow, veh/h	5202	1568	1740	5152	1774	1583
Grp Volume(v), veh/h	2221	119	123	2899	87	113
Grp Sat Flow(s),veh/h/ln	1679	1568	1740	1663	1774	1583
Q Serve(g_s), s	0.0	0.0	2.1	0.0	7.9	11.1
Cycle Q Clear(g_c), s	0.0	0.0	2.1	0.0	7.9	11.1
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	3904	1341	253	4313	142	212
V/C Ratio(X)	0.57	0.09	0.49	0.67	0.61	0.53
Avail Cap(c_a), veh/h	3904	1341	368	4313	202	265
HCM Platoon Ratio	2.00	2.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	0.63	0.63	0.26	0.26	1.00	1.00
Uniform Delay (d), s/veh	0.0	0.0	2.2	0.0	74.4	67.5
Incr Delay (d2), s/veh	0.4	0.1	0.4	0.2	4.2	2.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	0.0	1.0	0.1	4.1	5.0
LnGrp Delay(d),s/veh	0.4	0.1	2.6	0.2	78.6	69.6
LnGrp LOS	A	A	A	A	E	E
Approach Vol, veh/h	2340			3022	200	
Approach Delay, s/veh	0.4			0.3	73.5	
Approach LOS	A			A	E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	15.0	135.6				150.6		19.4
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	20.0	113.0				139.0		19.0
Max Q Clear Time (g_c+I1), s	4.1	2.0				2.0		13.1
Green Ext Time (p_c), s	0.2	108.2				132.7		0.3

Intersection Summary	
HCM 2010 Ctrl Delay	3.0
HCM 2010 LOS	A

F-4138

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑↑	↗	↰	↑↑↑	↰	↗
Volume (veh/h)	2716	100	128	2245	71	147
Number	2	12	1	6	3	18
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1845	1845	1863	1863
Adj Flow Rate, veh/h	3018	111	142	2494	79	163
Adj No. of Lanes	3	1	1	3	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	3	2	2
Cap, veh/h	3706	1266	214	4245	127	214
Arrive On Green	1.00	1.00	0.13	1.00	0.07	0.07
Sat Flow, veh/h	5202	1568	1757	5202	1774	1583
Grp Volume(v), veh/h	3018	111	142	2494	79	163
Grp Sat Flow(s),veh/h/ln	1679	1568	1757	1679	1774	1583
Q Serve(g_s), s	0.0	0.0	2.3	0.0	6.1	10.0
Cycle Q Clear(g_c), s	0.0	0.0	2.3	0.0	6.1	10.0
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	3706	1266	214	4245	127	214
V/C Ratio(X)	0.81	0.09	0.66	0.59	0.62	0.76
Avail Cap(c_a), veh/h	3706	1266	278	4245	127	214
HCM Platoon Ratio	2.00	2.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	0.27	0.27	0.37	0.37	1.00	1.00
Uniform Delay (d), s/veh	0.0	0.0	20.8	0.0	63.2	58.3
Incr Delay (d2), s/veh	0.6	0.0	1.4	0.2	9.1	14.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	3.9	0.1	3.3	6.9
LnGrp Delay(d),s/veh	0.6	0.0	22.2	0.2	72.3	72.9
LnGrp LOS	A	A	C	A	E	E
Approach Vol, veh/h	3129			2636	242	
Approach Delay, s/veh	0.5			1.4	72.7	
Approach LOS	A			A	E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	15.0	109.0				124.0		16.0
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	14.0	98.0				118.0		10.0
Max Q Clear Time (g_c+I1), s	4.3	2.0				2.0		12.0
Green Ext Time (p_c), s	0.2	94.9				114.4		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	3.8
HCM 2010 LOS	A

F-4139

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↟↟↟	↗	↰	↟↟↟	↗	↰	⇇↟	↗	↰	⇇↟	↗
Volume (veh/h)	222	1767	112	189	2428	353	146	79	177	212	90	146
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1827	1827	1827	1827	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	247	1963	124	210	2698	392	162	88	197	236	100	162
Adj No. of Lanes	1	3	1	1	3	1	2	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	4	4	4	2	2	2	2	2	2
Cap, veh/h	240	3015	1085	265	2787	1014	334	175	254	334	175	326
Arrive On Green	0.22	1.00	1.00	0.07	0.56	0.56	0.09	0.09	0.09	0.09	0.09	0.09
Sat Flow, veh/h	1740	4988	1553	1740	4988	1553	3548	1863	1583	3548	1863	1583
Grp Volume(v), veh/h	247	1963	124	210	2698	392	162	88	197	236	100	162
Grp Sat Flow(s),veh/h/ln	1740	1663	1553	1740	1663	1553	1774	1863	1583	1774	1863	1583
Q Serve(g_s), s	19.0	0.0	0.0	8.8	88.4	19.9	7.4	7.6	16.0	11.0	8.7	15.4
Cycle Q Clear(g_c), s	19.0	0.0	0.0	8.8	88.4	19.9	7.4	7.6	16.0	11.0	8.7	15.4
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	240	3015	1085	265	2787	1014	334	175	254	334	175	326
V/C Ratio(X)	1.03	0.65	0.11	0.79	0.97	0.39	0.49	0.50	0.78	0.71	0.57	0.50
Avail Cap(c_a), veh/h	240	3015	1085	427	2787	1014	334	175	254	334	175	326
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.78	0.78	0.78	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	54.0	0.0	0.0	15.7	36.0	13.7	73.1	73.2	68.5	74.7	73.7	59.7
Incr Delay (d2), s/veh	59.6	0.9	0.2	5.3	11.1	1.1	1.1	2.2	14.1	6.7	4.4	1.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	15.1	0.2	0.1	5.2	43.3	11.1	3.7	4.0	9.9	5.7	4.7	6.9
LnGrp Delay(d),s/veh	113.7	0.9	0.2	21.0	47.1	14.8	74.2	75.5	82.5	81.4	78.1	60.9
LnGrp LOS	F	A	A	C	D	B	E	E	F	F	E	E
Approach Vol, veh/h		2334			3300			447			498	
Approach Delay, s/veh		12.8			41.6			78.1			74.1	
Approach LOS		B			D			E			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	17.2	108.8		22.0	25.0	101.0		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	27.0	87.0		16.0	19.0	95.0		16.0
Max Q Clear Time (g_c+I1), s	10.8	2.0		17.4	21.0	90.4		18.0
Green Ext Time (p_c), s	0.5	82.4		0.0	0.0	4.6		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	36.3
HCM 2010 LOS	D

Notes

User approved volume balancing among the lanes for turning movement.

F-4140

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	⬆	⬆⬆⬆	⬆	⬆	⬆⬆⬆	⬆	⬆	⬅⬆	⬆	⬆	⬅⬆	⬆
Volume (veh/h)	217	2528	118	193	2084	269	110	95	188	320	170	179
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1845	1845	1845	1845	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	241	2809	131	214	2316	299	127	99	209	356	189	199
Adj No. of Lanes	1	3	1	1	3	1	2	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	3	3	3	2	2	2	2	2	2
Cap, veh/h	236	2662	1008	218	2518	963	405	213	294	405	213	339
Arrive On Green	0.20	1.00	1.00	0.07	0.50	0.50	0.11	0.11	0.11	0.11	0.11	0.11
Sat Flow, veh/h	1757	5036	1568	1757	5036	1568	3548	1863	1583	3548	1863	1583
Grp Volume(v), veh/h	241	2809	131	214	2316	299	127	99	209	356	189	199
Grp Sat Flow(s),veh/h/ln	1757	1679	1568	1757	1679	1568	1774	1863	1583	1774	1863	1583
Q Serve(g_s), s	14.0	0.0	0.0	9.6	59.6	12.7	4.6	7.0	16.0	13.8	14.0	15.8
Cycle Q Clear(g_c), s	14.0	0.0	0.0	9.6	59.6	12.7	4.6	7.0	16.0	13.8	14.0	15.8
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	236	2662	1008	218	2518	963	405	213	294	405	213	339
V/C Ratio(X)	1.02	1.06	0.13	0.98	0.92	0.31	0.31	0.47	0.71	0.88	0.89	0.59
Avail Cap(c_a), veh/h	236	2662	1008	218	2518	963	405	213	294	405	213	339
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.46	0.46	0.46	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	39.8	0.0	0.0	29.9	32.4	12.9	57.0	58.0	53.5	61.0	61.1	49.4
Incr Delay (d2), s/veh	45.8	29.9	0.1	54.8	6.9	0.8	0.4	1.6	7.8	19.1	33.2	2.6
Initial Q Delay(d3),s/veh	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.0	7.4	0.0	11.5	29.1	7.4	2.3	3.7	8.2	7.9	9.2	7.2
LnGrp Delay(d),s/veh	85.7	29.9	0.1	84.7	39.3	13.7	57.4	59.6	61.2	80.2	94.4	52.0
LnGrp LOS	F	F	A	F	D	B	E	E	E	F	F	D
Approach Vol, veh/h		3181			2829			435			744	
Approach Delay, s/veh		32.9			40.0			59.7			76.3	
Approach LOS		C			D			E			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	16.0	80.0		22.0	20.0	76.0		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	10.0	74.0		16.0	14.0	70.0		16.0
Max Q Clear Time (g_c+I1), s	11.6	2.0		17.8	16.0	61.6		18.0
Green Ext Time (p_c), s	0.0	71.0		0.0	0.0	8.4		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	41.8
HCM 2010 LOS	D

Notes

User approved volume balancing among the lanes for turning movement.

Appendix E

Traffic Analysis Worksheets

2018 Opening Year

Build River Center Site Alternatives 5-7

North Charleston Intersections

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑						↑↑↑	↗
Volume (veh/h)	0	0	0	0	147	0	0	0	0	0	1543	390
Number				7	4	14				5	2	12
Initial Q (Qb), veh				0	0	0				0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00				1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00				1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				0	1827	0				0	1827	1827
Adj Flow Rate, veh/h				0	163	0				0	1714	433
Adj No. of Lanes				0	2	0				0	3	1
Peak Hour Factor				0.90	0.90	0.90				0.90	0.90	0.90
Percent Heavy Veh, %				0	4	0				0	4	4
Cap, veh/h				0	520	0				0	3153	982
Arrive On Green				0.00	0.15	0.00				0.00	0.63	0.63
Sat Flow, veh/h				0	3654	0				0	5152	1553
Grp Volume(v), veh/h				0	163	0				0	1714	433
Grp Sat Flow(s),veh/h/ln				0	1736	0				0	1663	1553
Q Serve(g_s), s				0.0	2.3	0.0				0.0	10.6	7.8
Cycle Q Clear(g_c), s				0.0	2.3	0.0				0.0	10.6	7.8
Prop In Lane				0.00		0.00				0.00		1.00
Lane Grp Cap(c), veh/h				0	520	0				0	3153	982
V/C Ratio(X)				0.00	0.31	0.00				0.00	0.54	0.44
Avail Cap(c_a), veh/h				0	945	0				0	5705	1776
HCM Platoon Ratio				1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)				0.00	1.00	0.00				0.00	1.00	1.00
Uniform Delay (d), s/veh				0.0	20.9	0.0				0.0	5.7	5.2
Incr Delay (d2), s/veh				0.0	0.3	0.0				0.0	0.1	0.3
Initial Q Delay(d3),s/veh				0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				0.0	1.1	0.0				0.0	4.8	3.3
LnGrp Delay(d),s/veh				0.0	21.2	0.0				0.0	5.8	5.5
LnGrp LOS					C						A	A
Approach Vol, veh/h					163						2147	
Approach Delay, s/veh					21.2						5.8	
Approach LOS					C						A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4				
Phs Duration (G+Y+Rc), s		40.8		14.3				
Change Period (Y+Rc), s		6.0		6.0				
Max Green Setting (Gmax), s		63.0		15.0				
Max Q Clear Time (g_c+I1), s		12.6		4.3				
Green Ext Time (p_c), s		22.2		0.6				

Intersection Summary	
HCM 2010 Ctrl Delay	6.8
HCM 2010 LOS	A

F-4143

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations					↑↑						↑↑↑	↗
Volume (veh/h)	0	0	0	0	223	0	0	0	0	0	941	283
Number				7	4	14				5	2	12
Initial Q (Qb), veh				0	0	0				0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00				1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00				1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				0	1845	0				0	1827	1827
Adj Flow Rate, veh/h				0	248	0				0	1046	314
Adj No. of Lanes				0	2	0				0	3	1
Peak Hour Factor				0.90	0.90	0.90				0.90	0.90	0.90
Percent Heavy Veh, %				0	3	0				0	4	4
Cap, veh/h				0	772	0				0	2306	718
Arrive On Green				0.00	0.22	0.00				0.00	0.46	0.46
Sat Flow, veh/h				0	3689	0				0	5152	1553
Grp Volume(v), veh/h				0	248	0				0	1046	314
Grp Sat Flow(s),veh/h/ln				0	1752	0				0	1663	1553
Q Serve(g_s), s				0.0	2.2	0.0				0.0	5.4	5.2
Cycle Q Clear(g_c), s				0.0	2.2	0.0				0.0	5.4	5.2
Prop In Lane				0.00		0.00				0.00		1.00
Lane Grp Cap(c), veh/h				0	772	0				0	2306	718
V/C Ratio(X)				0.00	0.32	0.00				0.00	0.45	0.44
Avail Cap(c_a), veh/h				0	2317	0				0	6989	2176
HCM Platoon Ratio				1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)				0.00	1.00	0.00				0.00	1.00	1.00
Uniform Delay (d), s/veh				0.0	12.4	0.0				0.0	6.9	6.9
Incr Delay (d2), s/veh				0.0	0.2	0.0				0.0	0.1	0.4
Initial Q Delay(d3),s/veh				0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				0.0	1.1	0.0				0.0	2.5	2.3
LnGrp Delay(d),s/veh				0.0	12.6	0.0				0.0	7.1	7.3
LnGrp LOS					B						A	A
Approach Vol, veh/h					248						1360	
Approach Delay, s/veh					12.6						7.1	
Approach LOS					B						A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4				
Phs Duration (G+Y+Rc), s		23.5		14.3				
Change Period (Y+Rc), s		6.0		6.0				
Max Green Setting (Gmax), s		53.0		25.0				
Max Q Clear Time (g_c+I1), s		7.4		4.2				
Green Ext Time (p_c), s		10.1		1.4				

Intersection Summary	
HCM 2010 Ctrl Delay	8.0
HCM 2010 LOS	A

F-4144

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑						↑↑↑	↗			
Volume (veh/h)	0	380	0	0	0	0	0	783	96	0	0	0
Number	3	8	18				1	6	16			
Initial Q (Qb), veh	0	0	0				0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00			
Adj Sat Flow, veh/h/ln	0	1827	0				0	1810	1810			
Adj Flow Rate, veh/h	0	422	0				0	870	107			
Adj No. of Lanes	0	2	0				0	3	1			
Peak Hour Factor	0.90	0.90	0.90				0.90	0.90	0.90			
Percent Heavy Veh, %	0	4	0				0	5	5			
Cap, veh/h	0	836	0				0	2143	667			
Arrive On Green	0.00	0.24	0.00				0.00	0.43	0.43			
Sat Flow, veh/h	0	3654	0				0	5103	1538			
Grp Volume(v), veh/h	0	422	0				0	870	107			
Grp Sat Flow(s),veh/h/ln	0	1736	0				0	1647	1538			
Q Serve(g_s), s	0.0	3.9	0.0				0.0	4.5	1.6			
Cycle Q Clear(g_c), s	0.0	3.9	0.0				0.0	4.5	1.6			
Prop In Lane	0.00		0.00				0.00		1.00			
Lane Grp Cap(c), veh/h	0	836	0				0	2143	667			
V/C Ratio(X)	0.00	0.50	0.00				0.00	0.41	0.16			
Avail Cap(c_a), veh/h	0	3200	0				0	5894	1835			
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00			
Upstream Filter(I)	0.00	1.00	0.00				0.00	1.00	1.00			
Uniform Delay (d), s/veh	0.0	12.1	0.0				0.0	7.2	6.4			
Incr Delay (d2), s/veh	0.0	0.5	0.0				0.0	0.1	0.1			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	0.0	1.9	0.0				0.0	2.0	0.7			
LnGrp Delay(d),s/veh	0.0	12.6	0.0				0.0	7.3	6.5			
LnGrp LOS		B						A	A			
Approach Vol, veh/h		422						977				
Approach Delay, s/veh		12.6						7.2				
Approach LOS		B						A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs						6		8
Phs Duration (G+Y+Rc), s						22.0		14.9
Change Period (Y+Rc), s						6.0		6.0
Max Green Setting (Gmax), s						44.0		34.0
Max Q Clear Time (g_c+I1), s						6.5		5.9
Green Ext Time (p_c), s						6.9		2.8

Intersection Summary	
HCM 2010 Ctrl Delay	8.8
HCM 2010 LOS	A

F-4145

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑						↑↑↑	↱			
Volume (veh/h)	0	283	0	0	0	0	0	1419	177	0	0	0
Number	3	8	18				1	6	16			
Initial Q (Qb), veh	0	0	0				0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00			
Adj Sat Flow, veh/h/ln	0	1845	0				0	1827	1827			
Adj Flow Rate, veh/h	0	314	0				0	1577	197			
Adj No. of Lanes	0	2	0				0	3	1			
Peak Hour Factor	0.90	0.90	0.90				0.90	0.90	0.90			
Percent Heavy Veh, %	0	3	0				0	4	4			
Cap, veh/h	0	630	0				0	2879	896			
Arrive On Green	0.00	0.18	0.00				0.00	0.58	0.58			
Sat Flow, veh/h	0	3689	0				0	5152	1553			
Grp Volume(v), veh/h	0	314	0				0	1577	197			
Grp Sat Flow(s),veh/h/ln	0	1752	0				0	1663	1553			
Q Serve(g_s), s	0.0	4.0	0.0				0.0	9.7	3.0			
Cycle Q Clear(g_c), s	0.0	4.0	0.0				0.0	9.7	3.0			
Prop In Lane	0.00		0.00				0.00		1.00			
Lane Grp Cap(c), veh/h	0	630	0				0	2879	896			
V/C Ratio(X)	0.00	0.50	0.00				0.00	0.55	0.22			
Avail Cap(c_a), veh/h	0	1490	0				0	5756	1792			
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00			
Upstream Filter(I)	0.00	1.00	0.00				0.00	1.00	1.00			
Uniform Delay (d), s/veh	0.0	18.2	0.0				0.0	6.5	5.1			
Incr Delay (d2), s/veh	0.0	0.6	0.0				0.0	0.2	0.1			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	0.0	2.0	0.0				0.0	4.4	1.3			
LnGrp Delay(d),s/veh	0.0	18.9	0.0				0.0	6.6	5.2			
LnGrp LOS		B						A	A			
Approach Vol, veh/h		314						1774				
Approach Delay, s/veh		18.9						6.5				
Approach LOS		B						A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs						6		8
Phs Duration (G+Y+Rc), s						34.5		14.9
Change Period (Y+Rc), s						6.0		6.0
Max Green Setting (Gmax), s						57.0		21.0
Max Q Clear Time (g_c+I1), s						11.7		6.0
Green Ext Time (p_c), s						16.9		1.6

Intersection Summary	
HCM 2010 Ctrl Delay	8.3
HCM 2010 LOS	A

F-4146

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑	↗		↑		↰				↑↑↑	↗
Volume (veh/h)	0	143	45	0	0	0	46	0	0	0	1277	420
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1863	0	1863	0	1792	0	0	0	1810	1810
Adj Flow Rate, veh/h	0	159	50	0	0	0	51	0	0	0	1419	467
Adj No. of Lanes	0	1	1	0	1	0	1	0	0	0	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	2	0	2	0	6	0	0	0	5	5
Cap, veh/h	0	217	184	0	217	0	110	0	0	0	3667	1142
Arrive On Green	0.00	0.12	0.12	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.74	0.74
Sat Flow, veh/h	0	1863	1583	0	1863	0	1707	51	0	0	5103	1538
Grp Volume(v), veh/h	0	159	50	0	0	0	51	52.9		0	1419	467
Grp Sat Flow(s),veh/h/ln	0	1863	1583	0	1863	0	1707	D		0	1647	1538
Q Serve(g_s), s	0.0	9.1	3.2	0.0	0.0	0.0	3.2			0.0	11.5	12.4
Cycle Q Clear(g_c), s	0.0	9.1	3.2	0.0	0.0	0.0	3.2			0.0	11.5	12.4
Prop In Lane	0.00		1.00	0.00		0.00	1.00			0.00		1.00
Lane Grp Cap(c), veh/h	0	217	184	0	217	0	110			0	3667	1142
V/C Ratio(X)	0.00	0.73	0.27	0.00	0.00	0.00	0.46			0.00	0.39	0.41
Avail Cap(c_a), veh/h	0	438	373	0	438	0	201			0	3667	1142
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	0.00	0.00	0.00	1.00			0.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	47.2	44.5	0.0	0.0	0.0	49.8			0.0	5.1	5.3
Incr Delay (d2), s/veh	0.0	4.7	0.8	0.0	0.0	0.0	3.0			0.0	0.3	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	5.0	1.4	0.0	0.0	0.0	1.6			0.0	5.2	5.5
LnGrp Delay(d),s/veh	0.0	51.9	45.3	0.0	0.0	0.0	52.9			0.0	5.5	6.4
LnGrp LOS		D	D				D				A	A
Approach Vol, veh/h		209			0						1886	
Approach Delay, s/veh		50.3			0.0						5.7	
Approach LOS		D									A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4				8
Phs Duration (G+Y+Rc), s	13.1	88.0		18.9				18.9
Change Period (Y+Rc), s	6.0	6.0		6.0				6.0
Max Green Setting (Gmax), s	13.0	63.0		26.0				26.0
Max Q Clear Time (g_c+I1), s	5.2	14.4		12.1				0.0
Green Ext Time (p_c), s	0.0	17.0		0.8				0.0

Intersection Summary	
HCM 2010 Ctrl Delay	11.1
HCM 2010 LOS	B

F-4147

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑	↗		↑		↰				↑↑↑	↗
Volume (veh/h)	0	322	67	0	0	0	60	0	0	0	777	208
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1863	0	1863	0	1810	0	0	0	1827	1827
Adj Flow Rate, veh/h	0	358	74	0	0	0	67	0	0	0	863	231
Adj No. of Lanes	0	1	1	0	1	0	1	0	0	0	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	2	0	2	0	5	0	0	0	4	4
Cap, veh/h	0	434	369	0	434	0	126	0	0	0	3285	1023
Arrive On Green	0.00	0.23	0.23	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.66	0.66
Sat Flow, veh/h	0	1863	1583	0	1863	0	1723	67		0	5152	1553
Grp Volume(v), veh/h	0	358	74	0	0	0	67	50.7		0	863	231
Grp Sat Flow(s),veh/h/ln	0	1863	1583	0	1863	0	1723	D		0	1663	1553
Q Serve(g_s), s	0.0	19.3	4.0	0.0	0.0	0.0	4.0			0.0	7.5	6.3
Cycle Q Clear(g_c), s	0.0	19.3	4.0	0.0	0.0	0.0	4.0			0.0	7.5	6.3
Prop In Lane	0.00		1.00	0.00		0.00	1.00			0.00		1.00
Lane Grp Cap(c), veh/h	0	434	369	0	434	0	126			0	3285	1023
V/C Ratio(X)	0.00	0.82	0.20	0.00	0.00	0.00	0.53			0.00	0.26	0.23
Avail Cap(c_a), veh/h	0	828	704	0	828	0	228			0	3285	1023
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	0.00	0.00	0.00	1.00			0.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	38.5	32.6	0.0	0.0	0.0	47.2			0.0	7.4	7.2
Incr Delay (d2), s/veh	0.0	4.0	0.3	0.0	0.0	0.0	3.4			0.0	0.2	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	10.4	1.8	0.0	0.0	0.0	2.0			0.0	3.5	2.8
LnGrp Delay(d),s/veh	0.0	42.5	32.9	0.0	0.0	0.0	50.7			0.0	7.6	7.7
LnGrp LOS		D	C				D				A	A
Approach Vol, veh/h		432			0						1094	
Approach Delay, s/veh		40.8			0.0						7.7	
Approach LOS		D									A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4				8
Phs Duration (G+Y+Rc), s	13.7	75.6		30.6				30.6
Change Period (Y+Rc), s	6.0	6.0		6.0				6.0
Max Green Setting (Gmax), s	14.0	41.0		47.0				47.0
Max Q Clear Time (g_c+I1), s	6.0	9.5		22.3				0.0
Green Ext Time (p_c), s	0.1	7.2		2.4				0.0

Intersection Summary	
HCM 2010 Ctrl Delay	18.5
HCM 2010 LOS	B

F-4148

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑	↗		↑↑↠			↖	
Volume (veh/h)	0	0	0	0	14	196	0	516	75	73	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1863	1863	0	1759	1900	1792	0	0
Adj Flow Rate, veh/h	0	0	0	0	16	218	0	573	83	81	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	0	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	2	2	0	8	8	6	0	0
Cap, veh/h	0	206	0	0	206	1087	0	2447	350	158	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.11	0.11	0.00	0.58	0.58	0.09	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1863	1583	0	4406	607	1707	81	
Grp Volume(v), veh/h	0	0	0	0	16	218	0	430	226	81	37.8	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1863	1583	0	1601	1652	1707	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.6	4.1	0.0	5.4	5.5	3.7		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	0.6	4.1	0.0	5.4	5.5	3.7		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		0.37	1.00		
Lane Grp Cap(c), veh/h	0	206	0	0	206	1087	0	1845	952	158		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.08	0.20	0.00	0.23	0.24	0.51		
Avail Cap(c_a), veh/h	0	457	0	0	457	1301	0	1845	952	733		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	32.6	4.6	0.0	8.5	8.5	35.2		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.3	0.6	2.5		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	0.3	4.9	0.0	2.4	2.6	1.8		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	32.7	4.7	0.0	8.8	9.1	37.8		
LnGrp LOS					C	A		A	A	D		
Approach Vol, veh/h		0			234			656				
Approach Delay, s/veh		0.0			6.6			8.9				
Approach LOS					A			A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				15.0	13.6	53.0		15.0
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				20.0	35.0	47.0		20.0
Max Q Clear Time (g_c+I1), s				0.0	5.7	7.5		6.1
Green Ext Time (p_c), s				0.0	0.2	4.3		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	10.7
HCM 2010 LOS	B

F-4149

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑	↗		↑↑↳			↰	
Volume (veh/h)	0	0	0	0	4	237	0	1083	96	33	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1863	1863	0	1792	1900	1810	0	0
Adj Flow Rate, veh/h	0	0	0	0	4	263	0	1203	107	37	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	0	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	2	2	0	6	6	5	0	0
Cap, veh/h	0	183	0	0	183	1177	0	2951	262	103	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.64	0.64	0.06	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1863	1583	0	4737	407	1723	37	
Grp Volume(v), veh/h	0	0	0	0	4	263	0	858	452	37	43.4	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1863	1583	0	1631	1721	1723	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.2	4.7	0.0	11.6	11.6	1.9		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	0.2	4.7	0.0	11.6	11.6	1.9		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		0.24	1.00		
Lane Grp Cap(c), veh/h	0	183	0	0	183	1177	0	2104	1110	103		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.02	0.22	0.00	0.41	0.41	0.36		
Avail Cap(c_a), veh/h	0	224	0	0	224	1211	0	2104	1110	603		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	37.3	3.6	0.0	7.8	7.8	41.3		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.6	1.1	2.1		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	0.1	6.6	0.0	5.3	5.7	1.0		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	37.3	3.7	0.0	8.4	8.9	43.4		
LnGrp LOS					D	A		A	A	D		
Approach Vol, veh/h		0			267			1310				
Approach Delay, s/veh		0.0			4.2			8.6				
Approach LOS					A			A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				15.0	11.5	65.0		15.0
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				11.0	32.0	59.0		11.0
Max Q Clear Time (g_c+I1), s				0.0	3.9	13.6		6.7
Green Ext Time (p_c), s				0.0	0.1	10.7		0.4

Intersection Summary	
HCM 2010 Ctrl Delay	8.7
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑	↗		↑↑↑	↗	↘		
Volume (veh/h)	0	0	0	0	161	67	0	559	44	125	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1776	1776	0	1759	1759	1759	0	0
Adj Flow Rate, veh/h	0	0	0	0	179	74	0	621	49	139	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	1	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	7	7	0	8	8	8	0	0
Cap, veh/h	0	260	0	0	248	976	0	2434	758	190	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.14	0.14	0.00	0.51	0.51	0.11	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1776	1509	0	4961	1495	1675	139	
Grp Volume(v), veh/h	0	0	0	0	179	74	0	621	49	139	37.5	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1776	1509	0	1601	1495	1675	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	7.2	1.4	0.0	5.5	1.3	6.0		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	7.2	1.4	0.0	5.5	1.3	6.0		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		1.00	1.00		
Lane Grp Cap(c), veh/h	0	260	0	0	248	976	0	2434	758	190		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.72	0.08	0.00	0.26	0.06	0.73		
Avail Cap(c_a), veh/h	0	845	0	0	805	1449	0	2434	758	670		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	30.9	4.9	0.0	10.5	9.4	32.1		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.3	0.2	5.3		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	3.8	1.4	0.0	2.5	0.6	3.1		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	34.8	5.0	0.0	10.7	9.6	37.5		
LnGrp LOS					C	A		B	A	D		
Approach Vol, veh/h		0			253			670				
Approach Delay, s/veh		0.0			26.1			10.6				
Approach LOS					C			B				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				16.5	14.5	44.0		16.5
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				34.0	30.0	38.0		34.0
Max Q Clear Time (g_c+I1), s				0.0	8.0	7.5		9.2
Green Ext Time (p_c), s				0.0	0.3	4.4		1.3

Intersection Summary	
HCM 2010 Ctrl Delay	17.8
HCM 2010 LOS	B

F-4151

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑			↑	↗		↑↑↑	↗	↗		
Volume (veh/h)	0	0	0	0	105	108	0	1057	84	94	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1827	1827	0	1776	1776	1792	0	0
Adj Flow Rate, veh/h	0	0	0	0	117	120	0	1174	93	104	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	1	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	4	4	0	7	7	6	0	0
Cap, veh/h	0	181	0	0	178	1109	0	2992	932	155	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.62	0.62	0.09	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1827	1553	0	5007	1509	1707	104	
Grp Volume(v), veh/h	0	0	0	0	117	120	0	1174	93	104	45.6	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1827	1553	0	1616	1509	1707	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	5.7	2.2	0.0	11.3	2.3	5.4		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	5.7	2.2	0.0	11.3	2.3	5.4		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		1.00	1.00		
Lane Grp Cap(c), veh/h	0	181	0	0	178	1109	0	2992	932	155		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.66	0.11	0.00	0.39	0.10	0.67		
Avail Cap(c_a), veh/h	0	464	0	0	455	1345	0	2992	932	407		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	0.98	0.98	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	40.2	4.1	0.0	8.9	7.2	40.7		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	4.1	0.0	0.0	0.4	0.2	5.0		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	3.1	3.0	0.0	5.1	1.0	2.8		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	44.3	4.1	0.0	9.3	7.4	45.6		
LnGrp LOS					D	A		A	A	D		
Approach Vol, veh/h		0			237			1267				
Approach Delay, s/veh		0.0			23.9			9.2				
Approach LOS					C			A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				15.0	14.4	63.0		15.0
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				23.0	22.0	57.0		23.0
Max Q Clear Time (g_c+I1), s				0.0	7.4	13.3		7.7
Green Ext Time (p_c), s				0.0	0.2	10.3		0.9

Intersection Summary	
HCM 2010 Ctrl Delay	13.7
HCM 2010 LOS	B

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↰↱	↱	↰	↑↑↑	↑↑↑	↱
Volume (veh/h)	67	15	37	560	930	137
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1545	1545	1792	1792	1759	1759
Adj Flow Rate, veh/h	74	17	41	622	1033	152
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	23	23	6	6	8	8
Cap, veh/h	344	158	419	3535	3470	1080
Arrive On Green	0.12	0.12	1.00	1.00	0.72	0.72
Sat Flow, veh/h	2854	1313	453	5055	4961	1495
Grp Volume(v), veh/h	74	17	41	622	1033	152
Grp Sat Flow(s),veh/h/ln	1427	1313	453	1631	1601	1495
Q Serve(g_s), s	1.3	0.7	0.6	0.0	4.3	1.8
Cycle Q Clear(g_c), s	1.3	0.7	4.9	0.0	4.3	1.8
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	344	158	419	3535	3470	1080
V/C Ratio(X)	0.22	0.11	0.10	0.18	0.30	0.14
Avail Cap(c_a), veh/h	652	300	419	3535	3470	1080
HCM Platoon Ratio	1.00	1.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.95	0.95	1.00	1.00
Uniform Delay (d), s/veh	22.6	22.3	0.3	0.0	2.8	2.4
Incr Delay (d2), s/veh	0.3	0.3	0.4	0.1	0.2	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	0.2	0.1	0.0	1.9	0.8
LnGrp Delay(d),s/veh	22.9	22.6	0.7	0.1	3.0	2.7
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	91			663	1185	
Approach Delay, s/veh	22.9			0.1	3.0	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		47.1				47.1		12.9
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		35.0				35.0		13.0
Max Q Clear Time (g_c+I1), s		6.3				6.9		3.3
Green Ext Time (p_c), s		14.6				14.4		0.2

Intersection Summary	
HCM 2010 Ctrl Delay	2.9
HCM 2010 LOS	A

F-4153

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	ͱ͵	͵	ͱ	↟↟↟	↟↟↟	͵
Volume (veh/h)	129	43	37	945	697	84
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1624	1624	1827	1827	1776	1776
Adj Flow Rate, veh/h	143	48	41	1050	774	93
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	17	17	4	4	7	7
Cap, veh/h	449	206	518	3433	3337	1039
Arrive On Green	0.15	0.15	0.46	0.46	0.69	0.69
Sat Flow, veh/h	3000	1380	624	5152	5007	1509
Grp Volume(v), veh/h	143	48	41	1050	774	93
Grp Sat Flow(s),veh/h/ln	1500	1380	624	1663	1616	1509
Q Serve(g_s), s	2.4	1.8	2.3	7.6	3.4	1.2
Cycle Q Clear(g_c), s	2.4	1.8	5.7	7.6	3.4	1.2
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	449	206	518	3433	3337	1039
V/C Ratio(X)	0.32	0.23	0.08	0.31	0.23	0.09
Avail Cap(c_a), veh/h	733	337	518	3433	3337	1039
HCM Platoon Ratio	1.00	1.00	0.67	0.67	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.88	0.88	1.00	1.00
Uniform Delay (d), s/veh	21.8	21.5	7.4	6.8	3.3	3.0
Incr Delay (d2), s/veh	0.4	0.6	0.3	0.2	0.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	0.7	0.4	3.5	1.6	0.5
LnGrp Delay(d),s/veh	22.2	22.0	7.6	7.1	3.5	3.1
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	191			1091	867	
Approach Delay, s/veh	22.1			7.1	3.4	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		45.4				45.4		14.6
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		34.0				34.0		14.0
Max Q Clear Time (g_c+I1), s		5.4				9.6		4.4
Green Ext Time (p_c), s		15.6				14.2		0.4

Intersection Summary	
HCM 2010 Ctrl Delay	6.9
HCM 2010 LOS	A

F-4154

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↑	↱		↰↑↱		↰	↑↑	↱
Volume (veh/h)	68	68	5	126	87	130	18	432	185	163	636	152
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1743	1743	1900	1845	1845	1845	1900	1845	1900	1792	1792	1792
Adj Flow Rate, veh/h	76	76	6	140	97	144	20	480	206	181	707	169
Adj No. of Lanes	1	1	0	1	1	1	0	3	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	9	9	9	3	3	3	3	3	3	6	6	6
Cap, veh/h	288	431	34	251	265	225	81	1825	752	553	2376	1174
Arrive On Green	0.07	0.27	0.27	0.14	0.14	0.14	0.56	0.56	0.56	0.16	1.00	1.00
Sat Flow, veh/h	1660	1595	126	1298	1845	1568	81	3239	1336	1707	3406	1524
Grp Volume(v), veh/h	76	0	82	140	97	144	257	227	223	181	707	169
Grp Sat Flow(s),veh/h/ln	1660	0	1721	1298	1845	1568	1685	1528	1443	1707	1703	1524
Q Serve(g_s), s	4.1	0.0	4.1	11.6	5.3	9.7	0.0	8.5	8.9	4.6	0.0	0.0
Cycle Q Clear(g_c), s	4.1	0.0	4.1	11.6	5.3	9.7	7.9	8.5	8.9	4.6	0.0	0.0
Prop In Lane	1.00		0.07	1.00		1.00	0.08		0.93	1.00		1.00
Lane Grp Cap(c), veh/h	288	0	465	251	265	225	984	861	813	553	2376	1174
V/C Ratio(X)	0.26	0.00	0.18	0.56	0.37	0.64	0.26	0.26	0.27	0.33	0.30	0.14
Avail Cap(c_a), veh/h	330	0	725	414	496	422	984	861	813	644	2376	1174
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.97	0.97
Uniform Delay (d), s/veh	34.5	0.0	31.2	45.9	43.2	45.1	12.4	12.5	12.6	7.2	0.0	0.0
Incr Delay (d2), s/veh	0.5	0.0	0.2	1.9	0.8	3.0	0.6	0.7	0.8	0.3	0.3	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.9	0.0	2.0	4.3	2.8	4.4	4.2	3.8	3.7	2.1	0.1	0.1
LnGrp Delay(d),s/veh	35.0	0.0	31.4	47.8	44.1	48.1	13.0	13.2	13.4	7.5	0.3	0.3
LnGrp LOS	D		C	D	D	D	B	B	B	A	A	A
Approach Vol, veh/h		158			381			706			1057	
Approach Delay, s/veh		33.1			47.0			13.2			1.5	
Approach LOS		C			D			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		83.9	14.1	22.0	15.0	68.9		36.1
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		61.0	11.0	30.0	15.0	40.0		47.0
Max Q Clear Time (g_c+I1), s		2.0	6.1	13.6	6.6	10.9		6.1
Green Ext Time (p_c), s		14.3	0.1	1.7	0.3	11.9		2.0

Intersection Summary	
HCM 2010 Ctrl Delay	14.8
HCM 2010 LOS	B

F-4155

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↟		↱	↑	↗		↰↑↟		↱	↑↑	↗
Volume (veh/h)	108	120	5	118	57	150	5	757	205	128	464	116
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1776	1776	1900	1863	1863	1863	1900	1863	1900	1827	1827	1827
Adj Flow Rate, veh/h	120	133	6	131	63	167	6	841	228	142	516	129
Adj No. of Lanes	1	1	0	1	1	1	0	3	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	7	7	7	2	2	2	2	2	2	4	4	4
Cap, veh/h	314	456	21	238	262	222	36	2111	566	416	2353	1173
Arrive On Green	0.08	0.27	0.27	0.14	0.14	0.14	0.55	0.55	0.55	0.16	1.00	1.00
Sat Flow, veh/h	1691	1686	76	1245	1863	1583	7	3865	1036	1740	3471	1553
Grp Volume(v), veh/h	120	0	139	131	63	167	405	337	333	142	516	129
Grp Sat Flow(s),veh/h/ln	1691	0	1762	1245	1863	1583	1853	1543	1512	1740	1736	1553
Q Serve(g_s), s	6.7	0.0	7.1	11.5	3.4	11.5	0.0	14.5	14.6	3.6	0.0	0.0
Cycle Q Clear(g_c), s	6.7	0.0	7.1	11.5	3.4	11.5	14.4	14.5	14.6	3.6	0.0	0.0
Prop In Lane	1.00		0.04	1.00		1.00	0.01		0.68	1.00		1.00
Lane Grp Cap(c), veh/h	314	0	477	238	262	222	1044	842	826	416	2353	1173
V/C Ratio(X)	0.38	0.00	0.29	0.55	0.24	0.75	0.39	0.40	0.40	0.34	0.22	0.11
Avail Cap(c_a), veh/h	347	0	665	347	425	361	1044	842	826	477	2353	1173
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.98	0.98
Uniform Delay (d), s/veh	36.0	0.0	32.9	47.0	43.5	47.0	15.0	15.0	15.0	8.7	0.0	0.0
Incr Delay (d2), s/veh	0.8	0.0	0.3	2.0	0.5	5.0	1.1	1.4	1.5	0.5	0.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.1	0.0	3.5	4.1	1.8	5.4	7.6	6.4	6.4	1.7	0.1	0.1
LnGrp Delay(d),s/veh	36.8	0.0	33.2	49.0	44.0	52.1	16.1	16.4	16.5	9.2	0.2	0.2
LnGrp LOS	D		C	D	D	D	B	B	B	A	A	A
Approach Vol, veh/h		259			361			1075			787	
Approach Delay, s/veh		34.9			49.6			16.3			1.8	
Approach LOS		C			D			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		83.2	14.8	22.0	15.0	68.2		36.8
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		65.0	11.0	26.0	13.0	46.0		43.0
Max Q Clear Time (g_c+I1), s		2.0	8.7	13.5	5.6	16.6		9.1
Green Ext Time (p_c), s		16.3	0.1	1.7	0.2	13.1		2.2

Intersection Summary	
HCM 2010 Ctrl Delay	18.5
HCM 2010 LOS	B

F-4156

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⊕			⊕		↰	↑↑↱		↰	↑↑↱	
Volume (veh/h)	5	11	20	69	13	17	14	617	27	19	773	9
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1845	1900	1845	1845	1900	1845	1845	1900
Adj Flow Rate, veh/h	6	12	22	77	14	19	16	686	30	21	859	10
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	3	3	3	3	3	3	3	3	3
Cap, veh/h	111	176	252	380	72	69	346	1678	73	403	1740	20
Arrive On Green	0.28	0.28	0.28	0.28	0.28	0.28	0.49	0.49	0.49	0.49	0.49	0.49
Sat Flow, veh/h	110	638	914	946	262	252	628	3421	150	725	3548	41
Grp Volume(v), veh/h	40	0	0	110	0	0	16	351	365	21	424	445
Grp Sat Flow(s),veh/h/ln	1662	0	0	1460	0	0	628	1752	1818	725	1752	1837
Q Serve(g_s), s	0.0	0.0	0.0	1.9	0.0	0.0	0.9	6.5	6.6	1.0	8.3	8.3
Cycle Q Clear(g_c), s	0.9	0.0	0.0	2.8	0.0	0.0	9.2	6.5	6.6	7.5	8.3	8.3
Prop In Lane	0.15		0.55	0.70		0.17	1.00		0.08	1.00		0.02
Lane Grp Cap(c), veh/h	538	0	0	522	0	0	346	859	892	403	859	901
V/C Ratio(X)	0.07	0.00	0.00	0.21	0.00	0.00	0.05	0.41	0.41	0.05	0.49	0.49
Avail Cap(c_a), veh/h	914	0	0	855	0	0	676	1779	1845	784	1779	1865
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.8	0.0	0.0	14.4	0.0	0.0	11.9	8.3	8.3	10.7	8.8	8.8
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.2	0.0	0.0	0.1	0.3	0.3	0.1	0.4	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	0.0	1.2	0.0	0.0	0.2	3.2	3.3	0.2	4.1	4.3
LnGrp Delay(d),s/veh	13.8	0.0	0.0	14.6	0.0	0.0	11.9	8.6	8.6	10.8	9.2	9.2
LnGrp LOS	B			B			B	A	A	B	A	A
Approach Vol, veh/h		40			110			732			890	
Approach Delay, s/veh		13.8			14.6			8.7			9.2	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		31.1		20.1		31.1		20.1
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		52.0		26.0		52.0		26.0
Max Q Clear Time (g_c+I1), s		10.3		4.8		11.2		2.9
Green Ext Time (p_c), s		14.0		0.8		13.9		0.8

Intersection Summary	
HCM 2010 Ctrl Delay	9.5
HCM 2010 LOS	A

F-4157

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⬥			⬥		⬈	↑↑⬈		⬈	↑↑⬈	
Volume (veh/h)	6	7	13	42	19	29	20	933	53	18	572	8
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1863	1900	1845	1845	1900	1863	1863	1900
Adj Flow Rate, veh/h	7	8	14	47	21	32	22	1037	59	20	636	9
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	3	3	3	2	2	2
Cap, veh/h	135	148	192	239	112	122	474	1848	105	303	1958	28
Arrive On Green	0.24	0.24	0.24	0.24	0.24	0.24	0.55	0.55	0.55	0.55	0.55	0.55
Sat Flow, veh/h	235	610	789	604	461	501	774	3371	192	512	3573	51
Grp Volume(v), veh/h	29	0	0	100	0	0	22	539	557	20	315	330
Grp Sat Flow(s),veh/h/ln	1633	0	0	1566	0	0	774	1752	1811	512	1770	1854
Q Serve(g_s), s	0.0	0.0	0.0	0.4	0.0	0.0	0.9	11.5	11.5	1.5	5.6	5.6
Cycle Q Clear(g_c), s	0.7	0.0	0.0	2.7	0.0	0.0	6.5	11.5	11.5	13.1	5.6	5.6
Prop In Lane	0.24		0.48	0.47		0.32	1.00		0.11	1.00		0.03
Lane Grp Cap(c), veh/h	475	0	0	473	0	0	474	961	993	303	970	1016
V/C Ratio(X)	0.06	0.00	0.00	0.21	0.00	0.00	0.05	0.56	0.56	0.07	0.32	0.32
Avail Cap(c_a), veh/h	696	0	0	686	0	0	805	1708	1765	522	1725	1807
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	16.7	0.0	0.0	17.5	0.0	0.0	8.9	8.5	8.5	12.7	7.1	7.1
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.5	0.5	0.1	0.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	0.0	1.3	0.0	0.0	0.2	5.7	5.9	0.2	2.8	2.9
LnGrp Delay(d),s/veh	16.8	0.0	0.0	17.7	0.0	0.0	9.0	9.0	9.0	12.8	7.3	7.3
LnGrp LOS	B			B			A	A	A	B	A	A
Approach Vol, veh/h		29			100			1118			665	
Approach Delay, s/veh		16.8			17.7			9.0			7.5	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		37.5		20.0		37.5		20.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		56.0		22.0		56.0		22.0
Max Q Clear Time (g_c+I1), s		15.1		4.7		13.5		2.7
Green Ext Time (p_c), s		16.4		0.6		16.6		0.6

Intersection Summary	
HCM 2010 Ctrl Delay	9.0
HCM 2010 LOS	A

F-4158

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↻↾			↶	↗	↰	↑↑	↗	↰	↑↑	↗
Volume (veh/h)	39	52	11	124	78	113	9	563	269	158	775	48
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1759	1900	1900	1827	1827	1845	1845	1845	1845	1845	1845
Adj Flow Rate, veh/h	43	58	12	138	87	126	10	626	299	176	861	53
Adj No. of Lanes	0	2	0	0	1	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	8	8	8	4	4	4	3	3	3	3	3	3
Cap, veh/h	137	318	66	238	121	384	415	2078	929	540	2506	1121
Arrive On Green	0.25	0.25	0.25	0.25	0.25	0.25	1.00	1.00	1.00	0.07	0.71	0.71
Sat Flow, veh/h	318	1288	266	771	491	1553	602	3505	1568	1757	3505	1568
Grp Volume(v), veh/h	43	0	70	225	0	126	10	626	299	176	861	53
Grp Sat Flow(s),veh/h/ln	318	0	1554	1262	0	1553	602	1752	1568	1757	1752	1568
Q Serve(g_s), s	4.6	0.0	4.4	17.4	0.0	8.2	0.0	0.0	0.0	4.3	11.4	1.2
Cycle Q Clear(g_c), s	26.2	0.0	4.4	21.7	0.0	8.2	0.1	0.0	0.0	4.3	11.4	1.2
Prop In Lane	1.00		0.17	0.61		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	137	0	384	359	0	384	415	2078	929	540	2506	1121
V/C Ratio(X)	0.31	0.00	0.18	0.63	0.00	0.33	0.02	0.30	0.32	0.33	0.34	0.05
Avail Cap(c_a), veh/h	269	0	570	534	0	570	415	2078	929	713	2506	1121
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.97	0.00	0.97	0.94	0.94	0.94	0.88	0.88	0.88
Uniform Delay (d), s/veh	55.0	0.0	36.4	44.8	0.0	37.8	0.0	0.0	0.0	6.9	6.6	5.2
Incr Delay (d2), s/veh	1.3	0.0	0.2	1.7	0.0	0.5	0.1	0.4	0.9	0.3	0.3	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.5	0.0	1.9	7.2	0.0	3.6	0.0	0.1	0.2	2.1	5.6	0.6
LnGrp Delay(d),s/veh	56.3	0.0	36.6	46.6	0.0	38.3	0.1	0.4	0.9	7.2	6.9	5.2
LnGrp LOS	E		D	D		D	A	A	A	A	A	A
Approach Vol, veh/h		113			351			935			1090	
Approach Delay, s/veh		44.1			43.6			0.5			6.9	
Approach LOS		D			D			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		93.7		36.3	15.0	78.7		36.3
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		73.0		45.0	21.0	46.0		45.0
Max Q Clear Time (g_c+I1), s		13.4		23.7	6.3	2.1		28.2
Green Ext Time (p_c), s		18.4		2.3	0.4	17.0		2.2

Intersection Summary	
HCM 2010 Ctrl Delay	11.4
HCM 2010 LOS	B

F-4159

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↱			↰	↱	↰	↑↑	↱	↱	↑↑	↱
Volume (veh/h)	30	45	28	184	91	257	29	752	175	98	503	47
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1792	1900	1900	1845	1845	1845	1845	1845	1845	1845	1845
Adj Flow Rate, veh/h	33	50	31	204	101	286	32	836	194	109	559	52
Adj No. of Lanes	0	2	0	0	1	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	6	6	3	3	3	3	3	3	3	3	3
Cap, veh/h	121	289	189	309	129	478	483	1867	835	471	2287	1023
Arrive On Green	0.30	0.30	0.30	0.30	0.30	0.30	1.00	1.00	1.00	0.07	0.65	0.65
Sat Flow, veh/h	218	949	620	852	422	1568	799	3505	1568	1757	3505	1568
Grp Volume(v), veh/h	38	0	76	305	0	286	32	836	194	109	559	52
Grp Sat Flow(s),veh/h/ln	265	0	1522	1274	0	1568	799	1752	1568	1757	1752	1568
Q Serve(g_s), s	3.9	0.0	4.5	24.2	0.0	19.1	0.0	0.0	0.0	3.1	8.1	1.5
Cycle Q Clear(g_c), s	32.2	0.0	4.5	28.5	0.0	19.1	0.2	0.0	0.0	3.1	8.1	1.5
Prop In Lane	0.87		0.41	0.67		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	136	0	464	437	0	478	483	1867	835	471	2287	1023
V/C Ratio(X)	0.28	0.00	0.16	0.70	0.00	0.60	0.07	0.45	0.23	0.23	0.24	0.05
Avail Cap(c_a), veh/h	246	0	630	594	0	649	483	1867	835	502	2287	1023
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.91	0.00	0.91	0.90	0.90	0.90	0.96	0.96	0.96
Uniform Delay (d), s/veh	51.0	0.0	31.3	41.7	0.0	36.4	0.0	0.0	0.0	9.5	8.8	7.7
Incr Delay (d2), s/veh	1.1	0.0	0.2	2.0	0.0	1.1	0.2	0.7	0.6	0.2	0.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.3	0.0	1.9	9.8	0.0	8.4	0.0	0.2	0.1	1.5	4.0	0.7
LnGrp Delay(d),s/veh	52.1	0.0	31.5	43.7	0.0	37.5	0.2	0.7	0.6	9.7	9.1	7.8
LnGrp LOS	D		C	D		D	A	A	A	A	A	A
Approach Vol, veh/h		114			591			1062			720	
Approach Delay, s/veh		38.3			40.7			0.7			9.1	
Approach LOS		D			D			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		86.5		43.5	14.8	71.7		43.5
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		67.0		51.0	11.0	50.0		51.0
Max Q Clear Time (g_c+I1), s		10.1		30.5	5.1	2.2		34.2
Green Ext Time (p_c), s		15.9		3.5	0.1	15.3		3.3

Intersection Summary	
HCM 2010 Ctrl Delay	14.3
HCM 2010 LOS	B

F-4160

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	⬙	⬙	⬙	⬙⬙	⬙⬙	⬙
Volume (veh/h)	184	146	126	553	740	108
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1827	1827	1845	1845
Adj Flow Rate, veh/h	204	162	140	614	822	120
Adj No. of Lanes	1	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	4	4	3	3
Cap, veh/h	269	240	470	2433	2456	1099
Arrive On Green	0.16	0.16	0.93	0.93	0.70	0.70
Sat Flow, veh/h	1723	1538	581	3563	3597	1568
Grp Volume(v), veh/h	204	162	140	614	822	120
Grp Sat Flow(s),veh/h/ln	1723	1538	581	1736	1752	1568
Q Serve(g_s), s	7.0	6.1	4.2	1.0	5.7	1.5
Cycle Q Clear(g_c), s	7.0	6.1	9.8	1.0	5.7	1.5
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	269	240	470	2433	2456	1099
V/C Ratio(X)	0.76	0.67	0.30	0.25	0.33	0.11
Avail Cap(c_a), veh/h	446	398	470	2433	2456	1099
HCM Platoon Ratio	1.00	1.00	1.33	1.33	1.00	1.00
Upstream Filter(I)	0.91	0.91	0.80	0.80	0.94	0.94
Uniform Delay (d), s/veh	25.0	24.6	1.8	0.7	3.6	3.0
Incr Delay (d2), s/veh	3.9	3.0	1.3	0.2	0.3	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.6	2.8	0.8	0.5	2.7	0.7
LnGrp Delay(d),s/veh	28.9	27.6	3.0	0.9	4.0	3.2
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	366			754	942	
Approach Delay, s/veh	28.3			1.3	3.9	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		49.3				49.3		15.7
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		37.0				37.0		16.0
Max Q Clear Time (g_c+I1), s		7.7				11.8		9.0
Green Ext Time (p_c), s		14.5				13.4		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	7.3
HCM 2010 LOS	A

F-4161

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	٦	٦	٦	↟↟	↟↟	٦
Volume (veh/h)	171	102	186	812	563	156
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1845	1845	1845	1845
Adj Flow Rate, veh/h	190	113	207	902	626	173
Adj No. of Lanes	1	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	3	3	3	3
Cap, veh/h	250	223	588	2470	2470	1105
Arrive On Green	0.14	0.14	0.94	0.94	1.00	1.00
Sat Flow, veh/h	1740	1553	671	3597	3597	1568
Grp Volume(v), veh/h	190	113	207	902	626	173
Grp Sat Flow(s),veh/h/ln	1740	1553	671	1752	1752	1568
Q Serve(g_s), s	6.6	4.2	2.0	1.5	0.0	0.0
Cycle Q Clear(g_c), s	6.6	4.2	2.0	1.5	0.0	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	250	223	588	2470	2470	1105
V/C Ratio(X)	0.76	0.51	0.35	0.37	0.25	0.16
Avail Cap(c_a), veh/h	390	348	588	2470	2470	1105
HCM Platoon Ratio	1.00	1.00	1.33	1.33	2.00	2.00
Upstream Filter(I)	0.96	0.96	0.70	0.70	0.98	0.98
Uniform Delay (d), s/veh	25.7	24.7	0.6	0.6	0.0	0.0
Incr Delay (d2), s/veh	4.6	1.7	1.2	0.3	0.2	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.5	1.9	0.5	0.7	0.1	0.1
LnGrp Delay(d),s/veh	30.3	26.4	1.8	0.9	0.2	0.3
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	303			1109	799	
Approach Delay, s/veh	28.9			1.1	0.3	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		50.0				50.0		15.0
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		39.0				39.0		14.0
Max Q Clear Time (g_c+I1), s		2.0				4.0		8.6
Green Ext Time (p_c), s		18.3				17.8		0.4

Intersection Summary	
HCM 2010 Ctrl Delay	4.6
HCM 2010 LOS	A

F-4162

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑↾		↰	↑↑↾		↰	↑↑↾		↰	↑↑	↾
Volume (veh/h)	387	618	267	25	309	31	97	307	13	65	503	296
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1900	1827	1827	1900	1792	1792	1900	1827	1827	1827
Adj Flow Rate, veh/h	430	687	297	28	343	34	108	341	14	72	559	329
Adj No. of Lanes	1	2	0	1	2	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	4	4	4	6	6	6	4	4	4
Cap, veh/h	501	1010	437	147	502	49	403	1774	73	471	1428	989
Arrive On Green	0.23	0.43	0.43	0.16	0.16	0.16	0.14	1.00	1.00	0.82	0.82	0.82
Sat Flow, veh/h	1723	2339	1011	559	3193	314	1707	3335	137	1002	3471	1553
Grp Volume(v), veh/h	430	505	479	28	185	192	108	174	181	72	559	329
Grp Sat Flow(s),veh/h/ln	1723	1719	1631	559	1736	1771	1707	1703	1768	1002	1736	1553
Q Serve(g_s), s	24.5	28.9	28.9	5.4	12.3	12.5	4.1	0.0	0.0	1.8	5.2	4.9
Cycle Q Clear(g_c), s	24.5	28.9	28.9	5.4	12.3	12.5	4.1	0.0	0.0	1.8	5.2	4.9
Prop In Lane	1.00		0.62	1.00		0.18	1.00		0.08	1.00		1.00
Lane Grp Cap(c), veh/h	501	742	704	147	273	279	403	906	941	471	1428	989
V/C Ratio(X)	0.86	0.68	0.68	0.19	0.68	0.69	0.27	0.19	0.19	0.15	0.39	0.33
Avail Cap(c_a), veh/h	675	955	906	159	312	318	406	906	941	471	1428	989
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00
Upstream Filter(I)	0.69	0.69	0.69	0.97	0.97	0.97	0.99	0.99	0.99	0.93	0.93	0.93
Uniform Delay (d), s/veh	30.9	28.0	28.0	45.8	48.7	48.8	15.3	0.0	0.0	6.6	6.8	2.7
Incr Delay (d2), s/veh	5.9	0.9	1.0	0.6	4.8	5.0	0.4	0.5	0.5	0.6	0.8	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.4	13.9	13.2	0.9	6.3	6.5	1.9	0.1	0.1	0.6	2.4	2.2
LnGrp Delay(d),s/veh	36.8	28.9	29.0	46.4	53.5	53.7	15.7	0.5	0.5	7.2	7.6	3.5
LnGrp LOS	D	C	C	D	D	D	B	A	A	A	A	A
Approach Vol, veh/h		1414			405			463			960	
Approach Delay, s/veh		31.3			53.1			4.0			6.2	
Approach LOS		C			D			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4		6		8
Phs Duration (G+Y+Rc), s	14.8	56.4	33.6	25.3		71.1		58.9
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	9.0	35.0	40.0	22.0		50.0		68.0
Max Q Clear Time (g_c+I1), s	6.1	7.2	26.5	14.5		2.0		30.9
Green Ext Time (p_c), s	0.1	8.3	1.2	4.7		9.2		11.6

Intersection Summary	
HCM 2010 Ctrl Delay	22.7
HCM 2010 LOS	C

F-4163

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↴	↑↑↳		↴	↑↑↳		↴	↑↑↳		↴	↑↑	↴
Volume (veh/h)	402	344	130	22	612	70	271	505	37	47	348	321
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1900	1845	1845	1900	1827	1827	1900	1845	1845	1845
Adj Flow Rate, veh/h	447	382	144	24	680	78	301	561	41	52	387	357
Adj No. of Lanes	1	2	0	1	2	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	3	3	3	4	4	4	3	3	3
Cap, veh/h	476	1276	475	263	756	87	407	1369	100	234	772	704
Arrive On Green	0.23	0.51	0.51	0.24	0.24	0.24	0.30	0.83	0.83	0.29	0.29	0.29
Sat Flow, veh/h	1740	2478	922	865	3170	363	1740	3281	239	806	3505	1568
Grp Volume(v), veh/h	447	266	260	24	376	382	301	296	306	52	387	357
Grp Sat Flow(s),veh/h/ln	1740	1736	1664	865	1752	1781	1740	1736	1785	806	1752	1568
Q Serve(g_s), s	26.1	11.1	11.4	2.8	26.3	26.4	16.9	5.4	5.5	6.3	11.6	20.6
Cycle Q Clear(g_c), s	26.1	11.1	11.4	2.8	26.3	26.4	16.9	5.4	5.5	6.3	11.6	20.6
Prop In Lane	1.00		0.55	1.00		0.20	1.00		0.13	1.00		1.00
Lane Grp Cap(c), veh/h	476	894	857	263	418	424	407	724	745	234	772	704
V/C Ratio(X)	0.94	0.30	0.30	0.09	0.90	0.90	0.74	0.41	0.41	0.22	0.50	0.51
Avail Cap(c_a), veh/h	559	987	947	269	429	436	408	724	745	234	772	704
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.33	1.33	1.33
Upstream Filter(I)	0.91	0.91	0.91	0.88	0.88	0.88	0.96	0.96	0.96	0.97	0.97	0.97
Uniform Delay (d), s/veh	34.0	17.6	17.7	37.8	46.7	46.8	24.9	6.6	6.6	37.1	39.0	22.6
Incr Delay (d2), s/veh	20.7	0.2	0.2	0.1	19.2	19.1	6.7	1.6	1.6	2.1	2.3	2.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	18.0	5.4	5.2	0.7	15.0	15.2	8.8	2.7	2.8	1.6	5.9	9.4
LnGrp Delay(d),s/veh	54.6	17.8	17.8	37.9	65.9	65.9	31.6	8.2	8.2	39.3	41.3	25.1
LnGrp LOS	D	B	B	D	E	E	C	A	A	D	D	C
Approach Vol, veh/h		973			782			903			796	
Approach Delay, s/veh		34.7			65.0			16.0			33.9	
Approach LOS		C			E			B			C	

Timer	1	2	3	4	5	6	7	8				
Assigned Phs	1	2	3	4		6		8				
Phs Duration (G+Y+Rc), s	25.0	33.9	35.0	36.2		58.8		71.2				
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0		6.0		6.0				
Max Green Setting (Gmax), s	19.0	21.0	35.0	31.0		46.0		72.0				
Max Q Clear Time (g_c+I1), s	18.9	22.6	28.1	28.4		7.5		13.4				
Green Ext Time (p_c), s	0.0	0.0	0.9	1.8		9.7		10.7				

Intersection Summary	
HCM 2010 Ctrl Delay	36.5
HCM 2010 LOS	D

F-4164

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⟷			⟷		↱	↑↱		↱	↑↑	↱
Volume (veh/h)	15	52	118	15	44	120	26	293	18	93	568	37
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1827	1900	1900	1776	1900	1810	1810	1900	1792	1792	1792
Adj Flow Rate, veh/h	17	58	131	17	49	133	29	326	20	103	631	41
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	7	7	7	5	5	5	6	6	6
Cap, veh/h	46	85	169	46	73	172	612	2439	149	898	2959	1324
Arrive On Green	0.16	0.16	0.16	0.16	0.16	0.16	0.74	0.74	0.74	0.15	1.00	1.00
Sat Flow, veh/h	76	528	1056	76	456	1074	741	3292	201	1707	3406	1524
Grp Volume(v), veh/h	206	0	0	199	0	0	29	170	176	103	631	41
Grp Sat Flow(s),veh/h/ln	1660	0	0	1606	0	0	741	1719	1774	1707	1703	1524
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	0.0	1.2	3.3	3.3	1.2	0.0	0.0
Cycle Q Clear(g_c), s	13.4	0.0	0.0	13.3	0.0	0.0	1.2	3.3	3.3	1.2	0.0	0.0
Prop In Lane	0.08		0.64	0.09		0.67	1.00		0.11	1.00		1.00
Lane Grp Cap(c), veh/h	300	0	0	291	0	0	612	1274	1315	898	2959	1324
V/C Ratio(X)	0.69	0.00	0.00	0.68	0.00	0.00	0.05	0.13	0.13	0.11	0.21	0.03
Avail Cap(c_a), veh/h	721	0	0	698	0	0	612	1274	1315	1082	2959	1324
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	0.00	0.97	0.00	0.00	1.00	1.00	1.00	0.89	0.89	0.89
Uniform Delay (d), s/veh	46.2	0.0	0.0	46.2	0.0	0.0	4.0	4.3	4.3	1.7	0.0	0.0
Incr Delay (d2), s/veh	2.8	0.0	0.0	2.7	0.0	0.0	0.1	0.2	0.2	0.0	0.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	6.5	0.0	0.0	6.2	0.0	0.0	0.3	1.6	1.6	0.5	0.1	0.0
LnGrp Delay(d),s/veh	49.0	0.0	0.0	48.9	0.0	0.0	4.1	4.5	4.5	1.7	0.1	0.0
LnGrp LOS	D			D			A	A	A	A	A	A
Approach Vol, veh/h		206			199			375			775	
Approach Delay, s/veh		49.0			48.9			4.5			0.3	
Approach LOS		D			D			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		105.6		24.4	14.7	91.0		24.4
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		69.0		49.0	21.0	42.0		49.0
Max Q Clear Time (g_c+I1), s		2.0		15.3	3.2	5.3		15.4
Green Ext Time (p_c), s		8.2		3.0	0.2	7.8		3.0

Intersection Summary	
HCM 2010 Ctrl Delay	14.0
HCM 2010 LOS	B

F-4165

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⟷			⟷		⤚	⬆⬆		⤚	⬆⬆	⬂
Volume (veh/h)	58	53	50	16	70	155	77	552	30	90	358	61
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1810	1900	1827	1827	1900	1827	1827	1827
Adj Flow Rate, veh/h	64	59	56	18	78	172	86	613	33	100	398	68
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	5	5	5	4	4	4	4	4	4
Cap, veh/h	106	96	73	44	105	209	669	2254	121	647	2763	1236
Arrive On Green	0.20	0.20	0.20	0.20	0.20	0.20	0.67	0.67	0.67	0.15	1.00	1.00
Sat Flow, veh/h	328	487	371	61	529	1058	905	3351	180	1740	3471	1553
Grp Volume(v), veh/h	179	0	0	268	0	0	86	317	329	100	398	68
Grp Sat Flow(s),veh/h/ln	1186	0	0	1649	0	0	905	1736	1795	1740	1736	1553
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	0.0	4.1	8.7	8.7	1.7	0.0	0.0
Cycle Q Clear(g_c), s	18.3	0.0	0.0	18.2	0.0	0.0	4.1	8.7	8.7	1.7	0.0	0.0
Prop In Lane	0.36		0.31	0.07		0.64	1.00		0.10	1.00		1.00
Lane Grp Cap(c), veh/h	276	0	0	358	0	0	669	1167	1207	647	2763	1236
V/C Ratio(X)	0.65	0.00	0.00	0.75	0.00	0.00	0.13	0.27	0.27	0.15	0.14	0.06
Avail Cap(c_a), veh/h	550	0	0	658	0	0	669	1167	1207	740	2763	1236
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	0.00	0.98	0.00	0.00	1.00	1.00	1.00	0.80	0.80	0.80
Uniform Delay (d), s/veh	44.5	0.0	0.0	45.7	0.0	0.0	7.0	7.8	7.8	3.8	0.0	0.0
Incr Delay (d2), s/veh	2.6	0.0	0.0	3.1	0.0	0.0	0.4	0.6	0.6	0.1	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.8	0.0	0.0	8.7	0.0	0.0	1.1	4.3	4.5	0.8	0.0	0.0
LnGrp Delay(d),s/veh	47.1	0.0	0.0	48.7	0.0	0.0	7.4	8.4	8.3	3.9	0.1	0.1
LnGrp LOS	D			D			A	A	A	A	A	A
Approach Vol, veh/h		179			268			732			566	
Approach Delay, s/veh		47.1			48.7			8.2			0.8	
Approach LOS		D			D			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		100.5		29.5	14.7	85.9		29.5
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		72.0		46.0	15.0	51.0		46.0
Max Q Clear Time (g_c+I1), s		2.0		20.2	3.7	10.7		20.3
Green Ext Time (p_c), s		9.2		3.2	0.2	8.9		3.2

Intersection Summary	
HCM 2010 Ctrl Delay	16.0
HCM 2010 LOS	B

F-4166

Intersection

Int Delay, s/veh	2.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	0	233	139	19	379	340
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	250	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	8	8	2	2	5	5
Mvmt Flow	0	259	154	21	421	378

Major/Minor	Minor1			Major1		Major2	
Conflicting Flow All	1196	88		0	0	176	0
Stage 1	165	-		-	-	-	-
Stage 2	1031	-		-	-	-	-
Critical Hdwy	6.96	7.06		-	-	4.2	-
Critical Hdwy Stg 1	5.96	-		-	-	-	-
Critical Hdwy Stg 2	5.96	-		-	-	-	-
Follow-up Hdwy	3.58	3.38		-	-	2.25	-
Pot Cap-1 Maneuver	170	934		-	-	1376	-
Stage 1	830	-		-	-	-	-
Stage 2	292	-		-	-	-	-
Platoon blocked, %				-	-		-
Mov Cap-1 Maneuver	118	934		-	-	1376	-
Mov Cap-2 Maneuver	177	-		-	-	-	-
Stage 1	830	-		-	-	-	-
Stage 2	203	-		-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10.3		
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	934	1376	-
HCM Lane V/C Ratio	-	-	0.277	0.306	-
HCM Control Delay (s)	-	-	10.3	8.8	-
HCM Lane LOS	-	-	B	A	-
HCM 95th %tile Q(veh)	-	-	1	1	-

F-4167

Intersection

Int Delay, s/veh	4.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	0	338	299	33	231	146
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	250	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	7	7	2	2	4	4
Mvmt Flow	0	376	332	37	257	162

Major/Minor	Minor1			Major1		Major2	
Conflicting Flow All	945	184		0	0	369	0
Stage 1	351	-		-	-	-	-
Stage 2	594	-		-	-	-	-
Critical Hdwy	6.94	7.04		-	-	4.18	-
Critical Hdwy Stg 1	5.94	-		-	-	-	-
Critical Hdwy Stg 2	5.94	-		-	-	-	-
Follow-up Hdwy	3.57	3.37		-	-	2.24	-
Pot Cap-1 Maneuver	251	811		-	-	1172	-
Stage 1	669	-		-	-	-	-
Stage 2	501	-		-	-	-	-
Platoon blocked, %				-	-		-
Mov Cap-1 Maneuver	196	811		-	-	1172	-
Mov Cap-2 Maneuver	305	-		-	-	-	-
Stage 1	669	-		-	-	-	-
Stage 2	391	-		-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	13.2		
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	811	1172	-
HCM Lane V/C Ratio	-	-	0.463	0.219	-
HCM Control Delay (s)	-	-	13.2	8.9	-
HCM Lane LOS	-	-	B	A	-
HCM 95th %tile Q(veh)	-	-	2	1	-

F-4168

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↰	↱	↱	↑	↱	↱	↳	
Volume (veh/h)	4	55	4	31	6	31	4	181	8	80	322	5
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1810	1810	1776	1776	1776	1759	1759	1900
Adj Flow Rate, veh/h	4	61	4	34	7	34	4	201	9	89	358	6
Adj No. of Lanes	0	1	0	0	1	1	1	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	5	5	5	7	7	7	8	8	8
Cap, veh/h	102	535	33	510	90	485	400	695	591	522	675	11
Arrive On Green	0.32	0.32	0.32	0.32	0.32	0.32	0.39	0.39	0.39	0.39	0.39	0.39
Sat Flow, veh/h	28	1699	106	1108	286	1538	966	1776	1509	1102	1725	29
Grp Volume(v), veh/h	69	0	0	41	0	34	4	201	9	89	0	364
Grp Sat Flow(s),veh/h/ln	1834	0	0	1394	0	1538	966	1776	1509	1102	0	1754
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	0.6	0.1	3.2	0.1	2.5	0.0	6.5
Cycle Q Clear(g_c), s	1.1	0.0	0.0	0.7	0.0	0.6	6.6	3.2	0.1	5.6	0.0	6.5
Prop In Lane	0.06		0.06	0.83		1.00	1.00		1.00	1.00		0.02
Lane Grp Cap(c), veh/h	671	0	0	600	0	485	400	695	591	522	0	687
V/C Ratio(X)	0.10	0.00	0.00	0.07	0.00	0.07	0.01	0.29	0.02	0.17	0.00	0.53
Avail Cap(c_a), veh/h	897	0	0	770	0	677	731	1303	1108	899	0	1287
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	10.0	0.0	0.0	9.8	0.0	9.8	12.1	8.5	7.6	10.5	0.0	9.6
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.2	0.0	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.0	0.0	0.3	0.0	0.3	0.0	1.6	0.1	0.8	0.0	3.3
LnGrp Delay(d),s/veh	10.0	0.0	0.0	9.9	0.0	9.9	12.1	8.8	7.6	10.6	0.0	10.2
LnGrp LOS	B			A		A	B	A	A	B		B
Approach Vol, veh/h		69			75			214			453	
Approach Delay, s/veh		10.0			9.9			8.8			10.3	
Approach LOS		B			A			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		22.0		18.9		22.0		18.9
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		30.0		18.0		30.0		18.0
Max Q Clear Time (g_c+I1), s		8.5		2.7		8.6		3.1
Green Ext Time (p_c), s		3.8		0.6		3.7		0.5

Intersection Summary	
HCM 2010 Ctrl Delay	9.8
HCM 2010 LOS	A

F-4169

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↰	↱	↱	↑	↱	↘	↓	
Volume (veh/h)	4	7	4	10	27	63	4	300	18	43	226	4
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1810	1810	1810	1810	1810	1776	1776	1900
Adj Flow Rate, veh/h	4	8	4	11	30	70	4	333	20	48	251	4
Adj No. of Lanes	0	1	0	0	1	1	1	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	5	5	5	5	5	5	7	7	7
Cap, veh/h	184	309	127	197	436	464	503	722	613	436	695	11
Arrive On Green	0.30	0.30	0.30	0.30	0.30	0.30	0.40	0.40	0.40	0.40	0.40	0.40
Sat Flow, veh/h	238	1024	421	275	1442	1538	1088	1810	1538	976	1743	28
Grp Volume(v), veh/h	16	0	0	41	0	70	4	333	20	48	0	255
Grp Sat Flow(s),veh/h/ln	1683	0	0	1718	0	1538	1088	1810	1538	976	0	1771
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	1.3	0.1	5.4	0.3	1.5	0.0	4.1
Cycle Q Clear(g_c), s	0.3	0.0	0.0	0.6	0.0	1.3	4.2	5.4	0.3	7.0	0.0	4.1
Prop In Lane	0.25		0.25	0.27		1.00	1.00		1.00	1.00		0.02
Lane Grp Cap(c), veh/h	620	0	0	633	0	464	503	722	613	436	0	706
V/C Ratio(X)	0.03	0.00	0.00	0.06	0.00	0.15	0.01	0.46	0.03	0.11	0.00	0.36
Avail Cap(c_a), veh/h	857	0	0	876	0	690	883	1353	1150	777	0	1324
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	9.9	0.0	0.0	10.0	0.0	10.2	9.9	8.9	7.3	11.4	0.0	8.5
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.5	0.0	0.1	0.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	0.0	0.0	0.3	0.0	0.6	0.0	2.8	0.1	0.4	0.0	2.0
LnGrp Delay(d),s/veh	9.9	0.0	0.0	10.0	0.0	10.4	9.9	9.3	7.4	11.6	0.0	8.8
LnGrp LOS	A			B		B	A	A	A	B		A
Approach Vol, veh/h		16			111			357			303	
Approach Delay, s/veh		9.9			10.3			9.2			9.2	
Approach LOS		A			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		22.0		18.1		22.0		18.1
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		30.0		18.0		30.0		18.0
Max Q Clear Time (g_c+I1), s		9.0		3.3		7.4		2.3
Green Ext Time (p_c), s		3.7		0.4		3.8		0.4

Intersection Summary	
HCM 2010 Ctrl Delay	9.4
HCM 2010 LOS	A

F-4170

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰↰	↱	↑↳		↱	↑↑
Volume (veh/h)	9	14	183	16	17	342
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1667	1667	1810	1900	1776	1776
Adj Flow Rate, veh/h	10	16	203	18	19	380
Adj No. of Lanes	2	1	2	0	1	2
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	14	14	5	5	7	7
Cap, veh/h	180	83	1720	151	800	1815
Arrive On Green	0.06	0.06	0.54	0.54	0.54	0.54
Sat Flow, veh/h	3079	1417	3288	281	1101	3463
Grp Volume(v), veh/h	10	16	108	113	19	380
Grp Sat Flow(s),veh/h/ln	1540	1417	1719	1760	1101	1687
Q Serve(g_s), s	0.1	0.3	0.9	0.9	0.3	1.7
Cycle Q Clear(g_c), s	0.1	0.3	0.9	0.9	1.2	1.7
Prop In Lane	1.00	1.00		0.16	1.00	
Lane Grp Cap(c), veh/h	180	83	925	947	800	1815
V/C Ratio(X)	0.06	0.19	0.12	0.12	0.02	0.21
Avail Cap(c_a), veh/h	1657	762	1850	1894	1392	3630
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.2	13.3	3.4	3.4	3.7	3.6
Incr Delay (d2), s/veh	0.1	1.1	0.1	0.1	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	0.2	0.4	0.5	0.1	0.8
LnGrp Delay(d),s/veh	13.4	14.5	3.4	3.4	3.7	3.6
LnGrp LOS	B	B	A	A	A	A
Approach Vol, veh/h	26		221			399
Approach Delay, s/veh	14.0		3.4			3.6
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		22.0				22.0		7.7
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		32.0				32.0		16.0
Max Q Clear Time (g_c+I1), s		2.9				3.7		2.3
Green Ext Time (p_c), s		4.0				4.0		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	4.0
HCM 2010 LOS	A

F-4171

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	⤸⤸	⤵	↑↳		⤵	↑↑
Volume (veh/h)	6	12	322	24	19	240
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1712	1712	1827	1900	1810	1810
Adj Flow Rate, veh/h	7	13	358	27	21	267
Adj No. of Lanes	2	1	2	0	1	2
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	11	11	4	4	5	5
Cap, veh/h	146	67	1784	134	718	1874
Arrive On Green	0.05	0.05	0.55	0.55	0.55	0.55
Sat Flow, veh/h	3163	1455	3365	246	966	3529
Grp Volume(v), veh/h	7	13	189	196	21	267
Grp Sat Flow(s),veh/h/ln	1581	1455	1736	1784	966	1719
Q Serve(g_s), s	0.1	0.3	1.6	1.6	0.3	1.1
Cycle Q Clear(g_c), s	0.1	0.3	1.6	1.6	2.0	1.1
Prop In Lane	1.00	1.00		0.14	1.00	
Lane Grp Cap(c), veh/h	146	67	946	972	718	1874
V/C Ratio(X)	0.05	0.19	0.20	0.20	0.03	0.14
Avail Cap(c_a), veh/h	1724	793	1892	1944	1244	3748
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.4	13.5	3.4	3.4	3.9	3.3
Incr Delay (d2), s/veh	0.1	1.4	0.1	0.1	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	0.1	0.8	0.8	0.1	0.5
LnGrp Delay(d),s/veh	13.5	14.9	3.5	3.5	3.9	3.3
LnGrp LOS	B	B	A	A	A	A
Approach Vol, veh/h	20		385			288
Approach Delay, s/veh	14.4		3.5			3.4
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		22.0				22.0		7.4
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		32.0				32.0		16.0
Max Q Clear Time (g_c+I1), s		3.6				4.0		2.3
Green Ext Time (p_c), s		4.3				4.3		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	3.8
HCM 2010 LOS	A

F-4172

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Volume (veh/h)	12	175	72	90	108	10	19	54	120	17	119	12
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1900	1810	1810	1900	1696	1696	1900	1863	1863	1900
Adj Flow Rate, veh/h	13	194	80	100	120	11	21	60	133	19	132	13
Adj No. of Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	5	5	5	12	12	12	2	2	2
Cap, veh/h	467	341	141	495	833	76	372	132	292	333	467	46
Arrive On Green	0.28	0.28	0.28	0.13	0.51	0.51	0.28	0.28	0.28	0.28	0.28	0.28
Sat Flow, veh/h	1218	1218	502	1723	1633	150	1127	470	1042	1185	1669	164
Grp Volume(v), veh/h	13	0	274	100	0	131	21	0	193	19	0	145
Grp Sat Flow(s),veh/h/ln	1218	0	1721	1723	0	1783	1127	0	1512	1185	0	1834
Q Serve(g_s), s	0.4	0.0	7.8	2.0	0.0	2.2	0.8	0.0	6.0	0.8	0.0	3.5
Cycle Q Clear(g_c), s	0.4	0.0	7.8	2.0	0.0	2.2	4.4	0.0	6.0	6.8	0.0	3.5
Prop In Lane	1.00		0.29	1.00		0.08	1.00		0.69	1.00		0.09
Lane Grp Cap(c), veh/h	467	0	481	495	0	909	372	0	424	333	0	513
V/C Ratio(X)	0.03	0.00	0.57	0.20	0.00	0.14	0.06	0.00	0.46	0.06	0.00	0.28
Avail Cap(c_a), veh/h	851	0	1024	641	0	1623	569	0	688	540	0	834
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	15.0	0.0	17.6	10.4	0.0	7.4	17.8	0.0	17.0	19.8	0.0	16.1
Incr Delay (d2), s/veh	0.0	0.0	1.1	0.2	0.0	0.1	0.1	0.0	0.8	0.1	0.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	3.8	0.9	0.0	1.1	0.3	0.0	2.6	0.3	0.0	1.8
LnGrp Delay(d),s/veh	15.0	0.0	18.7	10.6	0.0	7.5	17.9	0.0	17.7	19.8	0.0	16.4
LnGrp LOS	B		B	B		A	B		B	B		B
Approach Vol, veh/h		287			231			214			164	
Approach Delay, s/veh		18.5			8.8			17.8			16.8	
Approach LOS		B			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6		8
Phs Duration (G+Y+Rc), s	13.2	22.0		22.0		35.1		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s	12.0	34.0		26.0		52.0		26.0
Max Q Clear Time (g_c+I1), s	4.0	9.8		8.8		4.2		8.0
Green Ext Time (p_c), s	0.1	2.5		2.0		2.8		2.0

Intersection Summary	
HCM 2010 Ctrl Delay	15.5
HCM 2010 LOS	B

F-4173

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↱		↰	↱		↰	↱		↰	↱	
Volume (veh/h)	13	102	44	97	173	15	46	114	105	5	45	13
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1900	1827	1827	1900	1712	1712	1900	1863	1863	1900
Adj Flow Rate, veh/h	14	113	49	108	192	17	51	127	117	6	50	14
Adj No. of Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	4	4	4	11	11	11	2	2	2
Cap, veh/h	444	337	146	594	847	75	434	229	211	292	391	109
Arrive On Green	0.28	0.28	0.28	0.13	0.51	0.51	0.28	0.28	0.28	0.28	0.28	0.28
Sat Flow, veh/h	1146	1210	525	1740	1655	146	1224	821	757	1131	1401	392
Grp Volume(v), veh/h	14	0	162	108	0	209	51	0	244	6	0	64
Grp Sat Flow(s),veh/h/ln	1146	0	1734	1740	0	1801	1224	0	1578	1131	0	1794
Q Serve(g_s), s	0.5	0.0	4.3	2.1	0.0	3.7	1.9	0.0	7.6	0.3	0.0	1.5
Cycle Q Clear(g_c), s	0.5	0.0	4.3	2.1	0.0	3.7	3.4	0.0	7.6	7.8	0.0	1.5
Prop In Lane	1.00		0.30	1.00		0.08	1.00		0.48	1.00		0.22
Lane Grp Cap(c), veh/h	444	0	483	594	0	922	434	0	440	292	0	500
V/C Ratio(X)	0.03	0.00	0.34	0.18	0.00	0.23	0.12	0.00	0.55	0.02	0.00	0.13
Avail Cap(c_a), veh/h	645	0	786	764	0	1413	797	0	908	627	0	1032
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	15.1	0.0	16.5	9.9	0.0	7.7	16.7	0.0	17.6	21.0	0.0	15.5
Incr Delay (d2), s/veh	0.0	0.0	0.4	0.1	0.0	0.1	0.1	0.0	1.1	0.0	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	2.1	1.0	0.0	1.8	0.6	0.0	3.4	0.1	0.0	0.8
LnGrp Delay(d),s/veh	15.1	0.0	16.9	10.0	0.0	7.9	16.8	0.0	18.7	21.0	0.0	15.6
LnGrp LOS	B		B	B		A	B		B	C		B
Approach Vol, veh/h		176			317			295			70	
Approach Delay, s/veh		16.7			8.6			18.4			16.0	
Approach LOS		B			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6		8
Phs Duration (G+Y+Rc), s	13.4	22.0		22.0		35.4		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s	13.0	26.0		33.0		45.0		33.0
Max Q Clear Time (g_c+I1), s	4.1	6.3		9.8		5.7		9.6
Green Ext Time (p_c), s	0.1	2.2		2.1		2.5		2.1

Intersection Summary	
HCM 2010 Ctrl Delay	14.2
HCM 2010 LOS	B

F-4174

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↑↱		↰	↑	↱	↰	↑	↱
Volume (veh/h)	161	39	249	50	47	32	118	297	72	76	485	127
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1827	1863	1863	1900	1727	1727	1727	1727	1727	1727
Adj Flow Rate, veh/h	179	43	277	56	52	36	131	330	80	84	539	141
Adj No. of Lanes	1	1	1	1	2	0	1	1	1	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	2	2	2	10	10	10	10	10	10
Cap, veh/h	436	488	415	384	557	352	345	919	782	500	919	782
Arrive On Green	0.27	0.27	0.27	0.27	0.27	0.27	0.53	0.53	0.53	0.53	0.53	0.53
Sat Flow, veh/h	1279	1827	1553	1055	2084	1316	702	1727	1468	901	1727	1468
Grp Volume(v), veh/h	179	43	277	56	43	45	131	330	80	84	539	141
Grp Sat Flow(s),veh/h/ln	1279	1827	1553	1055	1770	1630	702	1727	1468	901	1727	1468
Q Serve(g_s), s	7.3	1.1	9.5	2.5	1.1	1.2	9.3	6.6	1.6	3.6	12.7	3.0
Cycle Q Clear(g_c), s	8.6	1.1	9.5	3.6	1.1	1.2	22.0	6.6	1.6	10.2	12.7	3.0
Prop In Lane	1.00		1.00	1.00		0.81	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	436	488	415	384	473	436	345	919	782	500	919	782
V/C Ratio(X)	0.41	0.09	0.67	0.15	0.09	0.10	0.38	0.36	0.10	0.17	0.59	0.18
Avail Cap(c_a), veh/h	585	702	597	507	680	626	499	1298	1104	698	1298	1104
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	19.8	16.5	19.6	17.8	16.5	16.5	17.0	8.1	6.9	11.0	9.5	7.2
Incr Delay (d2), s/veh	0.6	0.1	1.9	0.2	0.1	0.1	0.7	0.2	0.1	0.2	0.6	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.7	0.5	4.3	0.7	0.5	0.6	1.8	3.2	0.7	0.9	6.1	1.2
LnGrp Delay(d),s/veh	20.4	16.5	21.4	18.0	16.6	16.6	17.7	8.3	7.0	11.2	10.1	7.4
LnGrp LOS	C	B	C	B	B	B	B	A	A	B	B	A
Approach Vol, veh/h		499			144			541			764	
Approach Delay, s/veh		20.6			17.1			10.4			9.7	
Approach LOS		C			B			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		37.9		22.0		37.9		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		45.0		23.0		45.0		23.0
Max Q Clear Time (g_c+I1), s		14.7		5.6		24.0		11.5
Green Ext Time (p_c), s		8.9		2.4		7.8		2.1

Intersection Summary	
HCM 2010 Ctrl Delay	13.3
HCM 2010 LOS	B

F-4175

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↑	↗	↰	↑↑		↰	↑	↗	↱	↑	↗
Volume (veh/h)	135	36	138	77	42	81	265	518	53	34	317	173
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1845	1863	1863	1900	1759	1759	1759	1759	1759	1759
Adj Flow Rate, veh/h	150	40	153	86	47	90	294	576	59	38	352	192
Adj No. of Lanes	1	1	1	1	2	0	1	1	1	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	2	2	2	8	8	8	8	8	8
Cap, veh/h	354	449	381	378	431	385	489	1010	859	383	1010	859
Arrive On Green	0.24	0.24	0.24	0.24	0.24	0.24	0.57	0.57	0.57	0.57	0.57	0.57
Sat Flow, veh/h	1235	1845	1568	1185	1770	1583	811	1759	1495	746	1759	1495
Grp Volume(v), veh/h	150	40	153	86	47	90	294	576	59	38	352	192
Grp Sat Flow(s),veh/h/ln	1235	1845	1568	1185	1770	1583	811	1759	1495	746	1759	1495
Q Serve(g_s), s	7.3	1.1	5.4	4.0	1.4	3.0	19.9	13.6	1.2	2.2	7.0	4.1
Cycle Q Clear(g_c), s	10.3	1.1	5.4	5.1	1.4	3.0	26.9	13.6	1.2	15.9	7.0	4.1
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	354	449	381	378	431	385	489	1010	859	383	1010	859
V/C Ratio(X)	0.42	0.09	0.40	0.23	0.11	0.23	0.60	0.57	0.07	0.10	0.35	0.22
Avail Cap(c_a), veh/h	429	561	477	450	538	482	615	1284	1091	499	1284	1091
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	24.1	19.2	20.9	21.2	19.3	20.0	14.6	8.9	6.2	13.9	7.5	6.8
Incr Delay (d2), s/veh	0.8	0.1	0.7	0.3	0.1	0.3	1.2	0.5	0.0	0.1	0.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.5	0.6	2.4	1.3	0.7	1.3	4.6	6.7	0.5	0.5	3.4	1.7
LnGrp Delay(d),s/veh	24.9	19.3	21.5	21.5	19.5	20.3	15.8	9.4	6.2	14.0	7.7	7.0
LnGrp LOS	C	B	C	C	B	C	B	A	A	B	A	A
Approach Vol, veh/h		343			223			929			582	
Approach Delay, s/veh		22.8			20.6			11.2			7.8	
Approach LOS		C			C			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		43.8		22.0		43.8		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		48.0		20.0		48.0		20.0
Max Q Clear Time (g_c+I1), s		17.9		7.1		28.9		12.3
Green Ext Time (p_c), s		10.8		2.0		8.9		1.6

Intersection Summary	
HCM 2010 Ctrl Delay	13.2
HCM 2010 LOS	B

F-4176

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	⇇	↑	↗	↱	⇆		↱	⇆		↱	↑	↗
Volume (veh/h)	312	97	198	4	42	4	93	228	4	4	441	241
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	950	1827	950	950	1900	1759	1736	1900	950	1727	1727
Adj Flow Rate, veh/h	347	108	220	4	47	4	103	253	4	4	490	268
Adj No. of Lanes	2	1	1	1	1	0	1	1	0	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	100	4	100	100	100	8	8	8	100	10	10
Cap, veh/h	444	386	631	197	173	15	238	756	12	288	766	844
Arrive On Green	0.13	0.41	0.41	0.20	0.20	0.20	0.44	0.44	0.44	0.44	0.44	0.44
Sat Flow, veh/h	3375	950	1553	534	864	73	665	1705	27	570	1727	1468
Grp Volume(v), veh/h	347	108	220	4	0	51	103	0	257	4	490	268
Grp Sat Flow(s),veh/h/ln	1688	950	1553	534	0	937	665	0	1731	570	1727	1468
Q Serve(g_s), s	8.0	6.1	7.8	0.5	0.0	3.7	11.4	0.0	7.8	0.4	17.6	7.6
Cycle Q Clear(g_c), s	8.0	6.1	7.8	0.5	0.0	3.7	29.0	0.0	7.8	8.1	17.6	7.6
Prop In Lane	1.00		1.00	1.00		0.08	1.00		0.02	1.00		1.00
Lane Grp Cap(c), veh/h	444	386	631	197	0	187	238	0	768	288	766	844
V/C Ratio(X)	0.78	0.28	0.35	0.02	0.00	0.27	0.43	0.00	0.33	0.01	0.64	0.32
Avail Cap(c_a), veh/h	633	439	718	197	0	187	284	0	888	327	885	946
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	33.6	15.9	16.4	25.8	0.0	27.1	28.6	0.0	14.5	17.2	17.3	8.8
Incr Delay (d2), s/veh	4.1	0.4	0.3	0.0	0.0	0.8	1.2	0.0	0.3	0.0	1.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.0	1.6	3.4	0.1	0.0	1.0	2.2	0.0	3.8	0.1	8.6	3.1
LnGrp Delay(d),s/veh	37.7	16.3	16.7	25.8	0.0	27.8	29.8	0.0	14.8	17.2	18.5	9.1
LnGrp LOS	D	B	B	C		C	C		B	B	B	A
Approach Vol, veh/h		675			55			360			762	
Approach Delay, s/veh		27.4			27.7			19.1			15.2	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4		6		8
Phs Duration (G+Y+Rc), s		41.5	16.5	22.0		41.5		38.5
Change Period (Y+Rc), s		6.0	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s		41.0	15.0	16.0		41.0		37.0
Max Q Clear Time (g_c+I1), s		19.6	10.0	5.7		31.0		9.8
Green Ext Time (p_c), s		6.5	0.6	1.3		4.4		1.8

Intersection Summary	
HCM 2010 Ctrl Delay	20.8
HCM 2010 LOS	C

F-4177

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	⻌⻌	↟	⻌	⻌	⻌		⻌	⻌		⻌	↟	⻌
Volume (veh/h)	325	42	91	12	89	4	234	475	4	4	262	317
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	950	1845	950	950	1900	1776	1764	1900	950	1759	1759
Adj Flow Rate, veh/h	361	47	101	13	99	4	260	528	4	4	291	352
Adj No. of Lanes	2	1	1	1	1	0	1	1	0	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	100	3	100	100	100	7	7	7	100	8	8
Cap, veh/h	443	367	605	201	169	7	360	829	6	193	834	903
Arrive On Green	0.13	0.39	0.39	0.19	0.19	0.19	0.47	0.47	0.47	0.47	0.47	0.47
Sat Flow, veh/h	3408	950	1568	630	907	37	747	1749	13	443	1759	1495
Grp Volume(v), veh/h	361	47	101	13	0	103	260	0	532	4	291	352
Grp Sat Flow(s),veh/h/ln	1704	950	1568	630	0	944	747	0	1762	443	1759	1495
Q Serve(g_s), s	8.8	2.7	3.6	1.5	0.0	8.6	28.9	0.0	19.5	0.6	8.9	10.5
Cycle Q Clear(g_c), s	8.8	2.7	3.6	1.5	0.0	8.6	37.8	0.0	19.5	20.1	8.9	10.5
Prop In Lane	1.00		1.00	1.00		0.04	1.00		0.01	1.00		1.00
Lane Grp Cap(c), veh/h	443	367	605	201	0	176	360	0	836	193	834	903
V/C Ratio(X)	0.82	0.13	0.17	0.06	0.00	0.59	0.72	0.00	0.64	0.02	0.35	0.39
Avail Cap(c_a), veh/h	516	410	676	216	0	198	363	0	842	195	841	909
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	36.3	17.0	17.3	29.0	0.0	31.9	26.1	0.0	17.0	24.6	14.2	8.8
Incr Delay (d2), s/veh	8.6	0.2	0.1	0.1	0.0	3.5	6.8	0.0	1.6	0.0	0.2	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.7	0.7	1.6	0.3	0.0	2.4	6.6	0.0	9.8	0.1	4.3	4.4
LnGrp Delay(d),s/veh	44.9	17.2	17.4	29.2	0.0	35.4	32.9	0.0	18.6	24.6	14.5	9.1
LnGrp LOS	D	B	B	C		D	C		B	C	B	A
Approach Vol, veh/h		509			116			792			647	
Approach Delay, s/veh		36.9			34.7			23.3			11.6	
Approach LOS		D			C			C			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4		6		8
Phs Duration (G+Y+Rc), s		46.7	17.1	22.0		46.7		39.1
Change Period (Y+Rc), s		6.0	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s		41.0	13.0	18.0		41.0		37.0
Max Q Clear Time (g_c+I1), s		22.1	10.8	10.6		39.8		5.6
Green Ext Time (p_c), s		8.2	0.3	0.8		0.9		1.5

Intersection Summary	
HCM 2010 Ctrl Delay	23.6
HCM 2010 LOS	C

F-4178

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔		↰	↱		↰	↱		↰	↱	
Volume (veh/h)	45	36	88	5	23	6	68	295	15	7	557	107
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1776	1900	1810	1810	1900	1776	1776	1900	1759	1759	1900
Adj Flow Rate, veh/h	50	40	98	6	26	7	76	328	17	8	619	119
Adj No. of Lanes	0	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	7	7	7	5	5	5	7	7	7	8	8	8
Cap, veh/h	134	110	191	386	328	88	288	971	50	574	832	160
Arrive On Green	0.24	0.24	0.24	0.24	0.24	0.24	0.58	0.58	0.58	0.58	0.58	0.58
Sat Flow, veh/h	272	463	801	1210	1374	370	684	1674	87	974	1435	276
Grp Volume(v), veh/h	188	0	0	6	0	33	76	0	345	8	0	738
Grp Sat Flow(s),veh/h/ln	1537	0	0	1210	0	1744	684	0	1760	974	0	1711
Q Serve(g_s), s	1.8	0.0	0.0	0.0	0.0	1.0	6.1	0.0	6.8	0.3	0.0	21.1
Cycle Q Clear(g_c), s	6.7	0.0	0.0	0.3	0.0	1.0	27.2	0.0	6.8	7.1	0.0	21.1
Prop In Lane	0.27		0.52	1.00		0.21	1.00		0.05	1.00		0.16
Lane Grp Cap(c), veh/h	435	0	0	386	0	416	288	0	1021	574	0	992
V/C Ratio(X)	0.43	0.00	0.00	0.02	0.00	0.08	0.26	0.00	0.34	0.01	0.00	0.74
Avail Cap(c_a), veh/h	531	0	0	464	0	528	491	0	1545	864	0	1501
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	21.7	0.0	0.0	19.3	0.0	19.5	20.3	0.0	7.2	9.1	0.0	10.2
Incr Delay (d2), s/veh	0.7	0.0	0.0	0.0	0.0	0.1	0.5	0.0	0.2	0.0	0.0	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.1	0.0	0.0	0.1	0.0	0.5	1.2	0.0	3.3	0.1	0.0	10.2
LnGrp Delay(d),s/veh	22.4	0.0	0.0	19.3	0.0	19.6	20.8	0.0	7.4	9.1	0.0	11.4
LnGrp LOS	C			B		B	C		A	A		B
Approach Vol, veh/h		188			39			421			746	
Approach Delay, s/veh		22.4			19.6			9.8			11.4	
Approach LOS		C			B			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		44.3		21.8		44.3		21.8
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		58.0		20.0		58.0		20.0
Max Q Clear Time (g_c+I1), s		23.1		3.0		29.2		8.7
Green Ext Time (p_c), s		9.7		1.2		9.2		0.9

Intersection Summary	
HCM 2010 Ctrl Delay	12.6
HCM 2010 LOS	B

F-4179

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔		↰	↱		↰	↱		↰	↱	
Volume (veh/h)	62	25	89	10	39	12	123	570	4	19	267	75
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1810	1900	1810	1810	1900	1792	1792	1900	1776	1776	1900
Adj Flow Rate, veh/h	69	28	99	11	43	13	137	633	4	21	297	83
Adj No. of Lanes	0	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	5	5	5	6	6	6	7	7	7
Cap, veh/h	202	99	218	485	379	115	473	889	6	298	667	187
Arrive On Green	0.28	0.28	0.28	0.28	0.28	0.28	0.50	0.50	0.50	0.50	0.50	0.50
Sat Flow, veh/h	402	349	767	1222	1335	404	961	1779	11	751	1336	373
Grp Volume(v), veh/h	196	0	0	11	0	56	137	0	637	21	0	380
Grp Sat Flow(s),veh/h/ln	1518	0	0	1222	0	1738	961	0	1790	751	0	1710
Q Serve(g_s), s	2.0	0.0	0.0	0.0	0.0	1.3	5.9	0.0	15.3	1.2	0.0	7.9
Cycle Q Clear(g_c), s	5.6	0.0	0.0	0.3	0.0	1.3	13.8	0.0	15.3	16.5	0.0	7.9
Prop In Lane	0.35		0.51	1.00		0.23	1.00		0.01	1.00		0.22
Lane Grp Cap(c), veh/h	519	0	0	485	0	493	473	0	894	298	0	854
V/C Ratio(X)	0.38	0.00	0.00	0.02	0.00	0.11	0.29	0.00	0.71	0.07	0.00	0.44
Avail Cap(c_a), veh/h	713	0	0	646	0	722	947	0	1778	668	0	1698
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	16.1	0.0	0.0	14.3	0.0	14.7	13.4	0.0	10.8	17.2	0.0	8.9
Incr Delay (d2), s/veh	0.5	0.0	0.0	0.0	0.0	0.1	0.3	0.0	1.1	0.1	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.5	0.0	0.0	0.1	0.0	0.6	1.6	0.0	7.7	0.3	0.0	3.8
LnGrp Delay(d),s/veh	16.6	0.0	0.0	14.3	0.0	14.8	13.7	0.0	11.8	17.3	0.0	9.3
LnGrp LOS	B			B		B	B		B	B		A
Approach Vol, veh/h		196			67			774			401	
Approach Delay, s/veh		16.6			14.7			12.2			9.7	
Approach LOS		B			B			B			A	

Timer	1	2	3	4	5	6	7	8	
Assigned Phs		2		4		6		8	
Phs Duration (G+Y+Rc), s		33.7		21.7		33.7		21.7	
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0	
Max Green Setting (Gmax), s		55.0		23.0		55.0		23.0	
Max Q Clear Time (g_c+I1), s		18.5		3.3		17.3		7.6	
Green Ext Time (p_c), s		9.1		1.5		9.2		1.3	

Intersection Summary	
HCM 2010 Ctrl Delay	12.2
HCM 2010 LOS	B

F-4180

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	53	0	350	86	0	590
Number	7	14	6	16	5	2
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1743	1743	1743	1743	0	1776
Adj Flow Rate, veh/h	59	0	389	0	0	656
Adj No. of Lanes	1	1	1	1	0	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	9	9	9	9	0	7
Cap, veh/h	185	165	965	821	0	983
Arrive On Green	0.11	0.00	0.55	0.00	0.00	0.55
Sat Flow, veh/h	1660	1482	1743	1482	0	1776
Grp Volume(v), veh/h	59	0	389	0	0	656
Grp Sat Flow(s),veh/h/ln	1660	1482	1743	1482	0	1776
Q Serve(g_s), s	1.2	0.0	4.6	0.0	0.0	9.4
Cycle Q Clear(g_c), s	1.2	0.0	4.6	0.0	0.0	9.4
Prop In Lane	1.00	1.00		1.00	0.00	
Lane Grp Cap(c), veh/h	185	165	965	821	0	983
V/C Ratio(X)	0.32	0.00	0.40	0.00	0.00	0.67
Avail Cap(c_a), veh/h	509	455	2771	2355	0	2823
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	0.00	1.00
Uniform Delay (d), s/veh	14.7	0.0	4.6	0.0	0.0	5.7
Incr Delay (d2), s/veh	1.0	0.0	0.3	0.0	0.0	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.0	2.2	0.0	0.0	4.6
LnGrp Delay(d),s/veh	15.7	0.0	4.9	0.0	0.0	6.4
LnGrp LOS	B		A			A
Approach Vol, veh/h	59		389			656
Approach Delay, s/veh	15.7		4.9			6.4
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		25.9		10.0		25.9		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		57.0		11.0		57.0		
Max Q Clear Time (g_c+I1), s		11.4		3.2		6.6		
Green Ext Time (p_c), s		8.5		0.1		8.6		

Intersection Summary	
HCM 2010 Ctrl Delay	6.4
HCM 2010 LOS	A

F-4181

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑	↱		↑
Volume (veh/h)	67	0	649	79	0	371
Number	7	14	6	16	5	2
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1776	1776	1776	1776	0	1792
Adj Flow Rate, veh/h	74	0	721	0	0	412
Adj No. of Lanes	1	1	1	1	0	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	7	7	7	7	0	6
Cap, veh/h	213	190	1025	871	0	1034
Arrive On Green	0.13	0.00	0.58	0.00	0.00	0.58
Sat Flow, veh/h	1691	1509	1776	1509	0	1792
Grp Volume(v), veh/h	74	0	721	0	0	412
Grp Sat Flow(s),veh/h/ln	1691	1509	1776	1509	0	1792
Q Serve(g_s), s	1.6	0.0	11.7	0.0	0.0	5.1
Cycle Q Clear(g_c), s	1.6	0.0	11.7	0.0	0.0	5.1
Prop In Lane	1.00	1.00		1.00	0.00	
Lane Grp Cap(c), veh/h	213	190	1025	871	0	1034
V/C Ratio(X)	0.35	0.00	0.70	0.00	0.00	0.40
Avail Cap(c_a), veh/h	461	411	2508	2132	0	2531
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	0.00	1.00
Uniform Delay (d), s/veh	16.1	0.0	6.1	0.0	0.0	4.7
Incr Delay (d2), s/veh	1.0	0.0	0.9	0.0	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	0.0	5.9	0.0	0.0	2.5
LnGrp Delay(d),s/veh	17.1	0.0	7.0	0.0	0.0	4.9
LnGrp LOS	B		A			A
Approach Vol, veh/h	74		721			412
Approach Delay, s/veh	17.1		7.0			4.9
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		29.3		11.1		29.3		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		57.0		11.0		57.0		
Max Q Clear Time (g_c+I1), s		7.1		3.6		13.7		
Green Ext Time (p_c), s		9.8		0.1		9.6		

Intersection Summary	
HCM 2010 Ctrl Delay	6.9
HCM 2010 LOS	A

F-4182

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↲↑↳			↲↔↳		↰	↑↳		↰	↑↳	
Volume (veh/h)	30	4	82	4	4	4	51	409	4	4	547	58
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1810	1900	1900	1863	1900	1743	1743	1900	1743	1743	1900
Adj Flow Rate, veh/h	33	4	91	4	4	4	57	454	4	4	608	64
Adj No. of Lanes	0	2	0	0	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	2	2	2	9	9	9	9	9	9
Cap, veh/h	417	44	343	175	169	131	309	950	8	462	854	90
Arrive On Green	0.24	0.24	0.24	0.24	0.24	0.24	0.55	0.55	0.55	0.55	0.55	0.55
Sat Flow, veh/h	1228	179	1400	380	688	534	714	1725	15	870	1551	163
Grp Volume(v), veh/h	37	0	91	12	0	0	57	0	458	4	0	672
Grp Sat Flow(s),veh/h/ln	1407	0	1400	1602	0	0	714	0	1740	870	0	1714
Q Serve(g_s), s	0.8	0.0	3.1	0.0	0.0	0.0	3.8	0.0	9.4	0.2	0.0	17.0
Cycle Q Clear(g_c), s	1.1	0.0	3.1	0.3	0.0	0.0	20.8	0.0	9.4	9.6	0.0	17.0
Prop In Lane	0.89		1.00	0.33		0.33	1.00		0.01	1.00		0.10
Lane Grp Cap(c), veh/h	461	0	343	474	0	0	309	0	958	462	0	944
V/C Ratio(X)	0.08	0.00	0.27	0.03	0.00	0.00	0.18	0.00	0.48	0.01	0.00	0.71
Avail Cap(c_a), veh/h	547	0	429	570	0	0	646	0	1779	873	0	1753
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	17.1	0.0	17.9	16.9	0.0	0.0	17.4	0.0	8.0	11.0	0.0	9.7
Incr Delay (d2), s/veh	0.1	0.0	0.4	0.0	0.0	0.0	0.3	0.0	0.4	0.0	0.0	1.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	0.0	1.2	0.1	0.0	0.0	0.8	0.0	4.6	0.0	0.0	8.1
LnGrp Delay(d),s/veh	17.2	0.0	18.3	16.9	0.0	0.0	17.7	0.0	8.4	11.0	0.0	10.8
LnGrp LOS	B		B	B			B		A	B		B
Approach Vol, veh/h		128			12			515			676	
Approach Delay, s/veh		18.0			16.9			9.4			10.8	
Approach LOS		B			B			A			B	

Timer	1	2	3	4	5	6	7	8				
Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		38.3		20.4		38.3		20.4				
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0				
Max Green Setting (Gmax), s		60.0		18.0		60.0		18.0				
Max Q Clear Time (g_c+I1), s		19.0		2.3		22.8		5.1				
Green Ext Time (p_c), s		9.7		0.6		9.6		0.6				

Intersection Summary	
HCM 2010 Ctrl Delay	11.0
HCM 2010 LOS	B

F-4183

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↲↳			↔		↰	↱		↰	↱	
Volume (veh/h)	28	4	50	4	4	4	74	615	4	4	456	29
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1810	1900	1900	1863	1900	1776	1776	1900	1776	1776	1900
Adj Flow Rate, veh/h	31	4	56	4	4	4	82	683	4	4	507	32
Adj No. of Lanes	0	2	0	0	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	2	2	2	7	7	7	7	7	7
Cap, veh/h	413	46	329	177	168	127	412	952	6	314	893	56
Arrive On Green	0.23	0.23	0.23	0.23	0.23	0.23	0.54	0.54	0.54	0.54	0.54	0.54
Sat Flow, veh/h	1216	194	1400	368	713	541	822	1764	10	717	1653	104
Grp Volume(v), veh/h	35	0	56	12	0	0	82	0	687	4	0	539
Grp Sat Flow(s),veh/h/ln	1410	0	1400	1623	0	0	822	0	1774	717	0	1757
Q Serve(g_s), s	0.7	0.0	1.7	0.0	0.0	0.0	3.9	0.0	15.5	0.2	0.0	10.8
Cycle Q Clear(g_c), s	1.0	0.0	1.7	0.3	0.0	0.0	14.8	0.0	15.5	15.7	0.0	10.8
Prop In Lane	0.89		1.00	0.33		0.33	1.00		0.01	1.00		0.06
Lane Grp Cap(c), veh/h	458	0	329	471	0	0	412	0	958	314	0	949
V/C Ratio(X)	0.08	0.00	0.17	0.03	0.00	0.00	0.20	0.00	0.72	0.01	0.00	0.57
Avail Cap(c_a), veh/h	603	0	473	632	0	0	893	0	1996	734	0	1978
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	16.0	0.0	16.3	15.7	0.0	0.0	13.0	0.0	9.2	15.1	0.0	8.1
Incr Delay (d2), s/veh	0.1	0.0	0.2	0.0	0.0	0.0	0.2	0.0	1.0	0.0	0.0	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	0.7	0.1	0.0	0.0	0.9	0.0	7.7	0.0	0.0	5.4
LnGrp Delay(d),s/veh	16.0	0.0	16.5	15.7	0.0	0.0	13.3	0.0	10.2	15.1	0.0	8.7
LnGrp LOS	B		B	B			B		B	B		A
Approach Vol, veh/h		91			12			769			543	
Approach Delay, s/veh		16.3			15.7			10.5			8.7	
Approach LOS		B			B			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		34.8		18.5		34.8		18.5
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		60.0		18.0		60.0		18.0
Max Q Clear Time (g_c+I1), s		17.7		2.3		17.5		3.7
Green Ext Time (p_c), s		11.1		0.4		11.1		0.4

Intersection Summary	
HCM 2010 Ctrl Delay	10.3
HCM 2010 LOS	B

F-4184

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↑↑↱		↱	↑↑↱		↱	↱		↱	↱	
Volume (veh/h)	15	7	4	4	4	89	4	402	4	152	369	15
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1667	1667	1900	1696	1696	1900	1743	1743	1900	1743	1743	1900
Adj Flow Rate, veh/h	17	8	4	4	4	99	4	447	4	169	410	17
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	14	14	14	12	12	12	9	9	9	9	9	9
Cap, veh/h	376	552	255	466	422	378	450	880	8	433	848	35
Arrive On Green	0.26	0.26	0.26	0.26	0.26	0.26	0.51	0.51	0.51	0.51	0.51	0.51
Sat Flow, veh/h	1151	2105	973	1272	1612	1442	895	1725	15	876	1662	69
Grp Volume(v), veh/h	17	6	6	4	4	99	4	0	451	169	0	427
Grp Sat Flow(s),veh/h/ln	1151	1583	1495	1272	1612	1442	895	0	1740	876	0	1731
Q Serve(g_s), s	0.6	0.1	0.2	0.1	0.1	2.9	0.2	0.0	9.0	8.3	0.0	8.5
Cycle Q Clear(g_c), s	3.5	0.1	0.2	0.3	0.1	2.9	8.6	0.0	9.0	17.4	0.0	8.5
Prop In Lane	1.00		0.65	1.00		1.00	1.00		0.01	1.00		0.04
Lane Grp Cap(c), veh/h	376	415	392	466	422	378	450	0	888	433	0	883
V/C Ratio(X)	0.05	0.01	0.02	0.01	0.01	0.26	0.01	0.00	0.51	0.39	0.00	0.48
Avail Cap(c_a), veh/h	489	571	539	591	581	520	995	0	1948	967	0	1938
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	16.8	14.4	14.4	14.5	14.4	15.4	11.2	0.0	8.5	14.3	0.0	8.4
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.5	0.6	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.1	0.1	0.0	0.0	1.2	0.0	0.0	4.4	2.1	0.0	4.1
LnGrp Delay(d),s/veh	16.8	14.4	14.4	14.5	14.4	15.8	11.2	0.0	9.0	14.8	0.0	8.8
LnGrp LOS	B	B	B	B	B	B	B		A	B		A
Approach Vol, veh/h		29			107			455			596	
Approach Delay, s/veh		15.8			15.7			9.0			10.5	
Approach LOS		B			B			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		32.9		19.8		32.9		19.8
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		59.0		19.0		59.0		19.0
Max Q Clear Time (g_c+I1), s		11.0		5.5		19.4		4.9
Green Ext Time (p_c), s		7.7		0.5		7.5		0.5

Intersection Summary	
HCM 2010 Ctrl Delay	10.5
HCM 2010 LOS	B

F-4185

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↑↑↱		↱	↑↑↱		↱	↱		↱	↱	
Volume (veh/h)	23	9	4	4	4	164	4	491	4	81	417	10
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1712	1712	1900	1727	1727	1900	1792	1792	1900	1776	1776	1900
Adj Flow Rate, veh/h	26	10	4	4	4	182	4	546	4	90	463	11
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	11	11	11	10	10	10	6	6	6	7	7	7
Cap, veh/h	328	652	245	491	462	414	411	889	7	358	865	21
Arrive On Green	0.28	0.28	0.28	0.28	0.28	0.28	0.50	0.50	0.50	0.50	0.50	0.50
Sat Flow, veh/h	1096	2315	869	1293	1641	1468	882	1777	13	814	1727	41
Grp Volume(v), veh/h	26	7	7	4	4	182	4	0	550	90	0	474
Grp Sat Flow(s),veh/h/ln	1096	1626	1558	1293	1641	1468	882	0	1790	814	0	1768
Q Serve(g_s), s	1.1	0.2	0.2	0.1	0.1	5.6	0.2	0.0	12.2	4.9	0.0	10.1
Cycle Q Clear(g_c), s	6.7	0.2	0.2	0.3	0.1	5.6	10.3	0.0	12.2	17.1	0.0	10.1
Prop In Lane	1.00		0.56	1.00		1.00	1.00		0.01	1.00		0.02
Lane Grp Cap(c), veh/h	328	458	439	491	462	414	411	0	896	358	0	885
V/C Ratio(X)	0.08	0.01	0.02	0.01	0.01	0.44	0.01	0.00	0.61	0.25	0.00	0.54
Avail Cap(c_a), veh/h	397	561	537	572	566	506	913	0	1917	822	0	1893
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	19.0	14.3	14.3	14.4	14.2	16.2	12.9	0.0	9.9	16.1	0.0	9.4
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.7	0.4	0.0	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.1	0.1	0.0	0.0	2.4	0.0	0.0	6.1	1.1	0.0	5.0
LnGrp Delay(d),s/veh	19.1	14.3	14.3	14.4	14.3	17.0	12.9	0.0	10.6	16.5	0.0	9.9
LnGrp LOS	B	B	B	B	B	B	B		B	B		A
Approach Vol, veh/h		40			190			554			564	
Approach Delay, s/veh		17.4			16.9			10.6			10.9	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		33.6		21.5		33.6		21.5
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		59.0		19.0		59.0		19.0
Max Q Clear Time (g_c+I1), s		14.2		8.7		19.1		7.6
Green Ext Time (p_c), s		8.6		0.9		8.4		0.9

Intersection Summary	
HCM 2010 Ctrl Delay	11.8
HCM 2010 LOS	B

F-4186

Intersection

Int Delay, s/veh	0.8

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	8	7	171	16	17	121
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	9	8	190	18	19	134

Major/Minor	Minor1			Major1		Major2	
Conflicting Flow All	371	199		0	0	208	0
Stage 1	199	-		-	-	-	-
Stage 2	172	-		-	-	-	-
Critical Hdwy	6.42	6.22		-	-	4.12	-
Critical Hdwy Stg 1	5.42	-		-	-	-	-
Critical Hdwy Stg 2	5.42	-		-	-	-	-
Follow-up Hdwy	3.518	3.318		-	-	2.218	-
Pot Cap-1 Maneuver	630	842		-	-	1363	-
Stage 1	835	-		-	-	-	-
Stage 2	858	-		-	-	-	-
Platoon blocked, %				-	-		-
Mov Cap-1 Maneuver	621	842		-	-	1363	-
Mov Cap-2 Maneuver	621	-		-	-	-	-
Stage 1	835	-		-	-	-	-
Stage 2	845	-		-	-	-	-

Approach	WB			NB		SB	
HCM Control Delay, s	10.2					0.9	
HCM LOS	B						

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	708	1363	-
HCM Lane V/C Ratio	-	-	0.024	0.014	-
HCM Control Delay (s)	-	-	10.2	7.7	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0	0	-

F-4187

Intersection

Int Delay, s/veh	1.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	15	18	116	7	8	185
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	17	20	129	8	9	206

Major/Minor	Minor1			Major1		Major2	
Conflicting Flow All	356	133		0	0	137	0
Stage 1	133	-		-	-	-	-
Stage 2	223	-		-	-	-	-
Critical Hdwy	6.42	6.22		-	-	4.12	-
Critical Hdwy Stg 1	5.42	-		-	-	-	-
Critical Hdwy Stg 2	5.42	-		-	-	-	-
Follow-up Hdwy	3.518	3.318		-	-	2.218	-
Pot Cap-1 Maneuver	642	916		-	-	1447	-
Stage 1	893	-		-	-	-	-
Stage 2	814	-		-	-	-	-
Platoon blocked, %				-	-		-
Mov Cap-1 Maneuver	638	916		-	-	1447	-
Mov Cap-2 Maneuver	638	-		-	-	-	-
Stage 1	893	-		-	-	-	-
Stage 2	808	-		-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	9.9		0.3
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	765	1447	-
HCM Lane V/C Ratio	-	-	0.048	0.006	-
HCM Control Delay (s)	-	-	9.9	7.5	0
HCM Lane LOS	-	-	A	A	A
HCM 95th %tile Q(veh)	-	-	0	0	-

F-4188

Intersection

Int Delay, s/veh	4.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	30	4	160	4	4	5	87	43	6
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2
Mvmt Flow	33	4	178	4	4	6	97	48	7

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	412	441	97	343	446	27	193	0	0
Stage 1	193	193	-	244	244	-	-	-	-
Stage 2	219	248	-	99	202	-	-	-	-
Critical Hdwy	7.54	6.54	6.94	7.54	6.54	6.94	4.14	-	-
Critical Hdwy Stg 1	6.54	5.54	-	6.54	5.54	-	-	-	-
Critical Hdwy Stg 2	6.54	5.54	-	6.54	5.54	-	-	-	-
Follow-up Hdwy	3.52	4.02	3.32	3.52	4.02	3.32	2.22	-	-
Pot Cap-1 Maneuver	524	509	940	587	506	1042	1378	-	-
Stage 1	790	740	-	738	703	-	-	-	-
Stage 2	763	700	-	896	733	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	487	470	940	445	468	1042	1378	-	-
Mov Cap-2 Maneuver	487	470	-	445	468	-	-	-	-
Stage 1	732	738	-	684	652	-	-	-	-
Stage 2	699	649	-	720	731	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	10.3	11.3	
HCM LOS	B	B	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1378	-	-	485	940	582	1535	-	-
HCM Lane V/C Ratio	0.07	-	-	0.078	0.189	0.025	0.003	-	-
HCM Control Delay (s)	7.8	0.1	-	13	9.7	11.3	7.4	0	-
HCM Lane LOS	A	A	-	B	A	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	1	0	0	-	-

F-4189

Intersection

Int Delay, s/veh

Movement	SBL	SBT	SBR
Vol, veh/h	4	158	16
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	4	4	4
Mvmt Flow	4	176	18

Major/Minor	Major2		
Conflicting Flow All	54	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.18	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.24	-	-
Pot Cap-1 Maneuver	1535	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1535	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

F-4190

Intersection

Int Delay, s/veh	2.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	14	4	92	5	4	5	154	138	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2
Mvmt Flow	16	4	102	6	4	6	171	153	6

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	512	592	52	540	612	79	103	0	0
Stage 1	91	91	-	498	498	-	-	-	-
Stage 2	421	501	-	42	114	-	-	-	-
Critical Hdwy	7.54	6.54	6.94	7.54	6.54	6.94	4.14	-	-
Critical Hdwy Stg 1	6.54	5.54	-	6.54	5.54	-	-	-	-
Critical Hdwy Stg 2	6.54	5.54	-	6.54	5.54	-	-	-	-
Follow-up Hdwy	3.52	4.02	3.32	3.52	4.02	3.32	2.22	-	-
Pot Cap-1 Maneuver	445	418	1005	425	407	965	1487	-	-
Stage 1	906	819	-	523	543	-	-	-	-
Stage 2	581	541	-	967	800	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	394	364	1005	340	354	965	1487	-	-
Mov Cap-2 Maneuver	394	364	-	340	354	-	-	-	-
Stage 1	792	815	-	457	475	-	-	-	-
Stage 2	500	473	-	860	796	-	-	-	-

Approach	EB		WB		NB	
HCM Control Delay, s	9.9		13.3			
HCM LOS	A		B			

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1487	-	-	387	1005	449	1403	-	-
HCM Lane V/C Ratio	0.115	-	-	0.052	0.102	0.035	0.004	-	-
HCM Control Delay (s)	7.7	0.2	-	14.8	9	13.3	7.6	0	-
HCM Lane LOS	A	A	-	B	A	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	0	0	0	-	-

F-4191

Intersection

Int Delay, s/veh

Movement	SBL	SBT	SBR
Vol, veh/h	5	51	42
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	4	4	4
Mvmt Flow	6	57	47

Major/Minor	Major2		
Conflicting Flow All	159	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.18	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.24	-	-
Pot Cap-1 Maneuver	1403	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1403	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

F-4192

Intersection

Intersection Delay, s/veh	11.2
Intersection LOS	B

Movement	WBU	WBL	WBR	NBU	NBT	NBR	SBU	SBL	SBT
Vol, veh/h	0	13	62	0	105	15	0	143	196
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles, %	2	2	2	2	2	2	2	4	4
Mvmt Flow	0	14	69	0	117	17	0	159	218
Number of Lanes	0	1	1	0	1	1	0	0	1

Approach	WB		NB	SB
Opposing Approach			SB	NB
Opposing Lanes	0		1	2
Conflicting Approach Left	NB			WB
Conflicting Lanes Left	2		0	2
Conflicting Approach Right	SB		WB	
Conflicting Lanes Right	1		2	0
HCM Control Delay	8.5		8.6	12.7
HCM LOS	A		A	B

Lane	NBLn1	NBLn2	WBLn1	WBLn2	SBLn1
Vol Left, %	0%	0%	100%	0%	42%
Vol Thru, %	100%	0%	0%	0%	58%
Vol Right, %	0%	100%	0%	100%	0%
Sign Control	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	105	15	13	62	339
LT Vol	105	0	0	0	196
Through Vol	0	15	0	62	0
RT Vol	0	0	13	0	143
Lane Flow Rate	117	17	14	69	377
Geometry Grp	7	7	7	7	4
Degree of Util (X)	0.164	0.02	0.025	0.097	0.505
Departure Headway (Hd)	5.06	4.355	6.273	5.063	4.825
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes
Cap	709	822	571	707	750
Service Time	2.787	2.082	4.009	2.799	2.847
HCM Lane V/C Ratio	0.165	0.021	0.025	0.098	0.503
HCM Control Delay	8.8	7.2	9.2	8.3	12.7
HCM Lane LOS	A	A	A	A	B
HCM 95th-tile Q	0.6	0.1	0.1	0.3	2.9

F-4193

Intersection

Intersection Delay, s/veh	9.7
Intersection LOS	A

Movement	WBU	WBL	WBR	NBU	NBT	NBR	SBU	SBL	SBT
Vol, veh/h	0	14	155	0	180	12	0	56	114
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles, %	2	2	2	2	2	2	2	4	4
Mvmt Flow	0	16	172	0	200	13	0	62	127
Number of Lanes	0	1	1	0	1	1	0	0	1

Approach	WB	NB	SB
Opposing Approach		SB	NB
Opposing Lanes	0	1	2
Conflicting Approach Left	NB		WB
Conflicting Lanes Left	2	0	2
Conflicting Approach Right	SB	WB	
Conflicting Lanes Right	1	2	0
HCM Control Delay	9.1	9.8	10.1
HCM LOS	A	A	B

Lane	NBLn1	NBLn2	WBLn1	WBLn2	SBLn1
Vol Left, %	0%	0%	100%	0%	33%
Vol Thru, %	100%	0%	0%	0%	67%
Vol Right, %	0%	100%	0%	100%	0%
Sign Control	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	180	12	14	155	170
LT Vol	180	0	0	0	114
Through Vol	0	12	0	155	0
RT Vol	0	0	14	0	56
Lane Flow Rate	200	13	16	172	189
Geometry Grp	7	7	7	7	4
Degree of Util (X)	0.288	0.017	0.026	0.232	0.271
Departure Headway (Hd)	5.182	4.477	6.051	4.843	5.164
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes
Cap	692	796	591	739	693
Service Time	2.928	2.224	3.795	2.586	3.213
HCM Lane V/C Ratio	0.289	0.016	0.027	0.233	0.273
HCM Control Delay	10	7.3	9	9.1	10.1
HCM Lane LOS	A	A	A	A	B
HCM 95th-tile Q	1.2	0.1	0.1	0.9	1.1

F-4194

Intersection

Int Delay, s/veh	1.4

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	8	26	158	8	67	357
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	14	14	4	4	6	6
Mvmt Flow	9	29	176	9	74	397

Major/Minor	Minor1			Major1		Major2	
Conflicting Flow All	726	180		0	0	184	0
Stage 1	180	-		-	-	-	-
Stage 2	546	-		-	-	-	-
Critical Hdwy	6.54	6.34		-	-	4.16	-
Critical Hdwy Stg 1	5.54	-		-	-	-	-
Critical Hdwy Stg 2	5.54	-		-	-	-	-
Follow-up Hdwy	3.626	3.426		-	-	2.254	-
Pot Cap-1 Maneuver	374	833		-	-	1367	-
Stage 1	823	-		-	-	-	-
Stage 2	557	-		-	-	-	-
Platoon blocked, %				-	-		-
Mov Cap-1 Maneuver	348	833		-	-	1367	-
Mov Cap-2 Maneuver	348	-		-	-	-	-
Stage 1	823	-		-	-	-	-
Stage 2	519	-		-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	11.1		1.2
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	627	1367	-
HCM Lane V/C Ratio	-	-	0.06	0.054	-
HCM Control Delay (s)	-	-	11.1	7.8	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0	0	-

F-4195

Intersection

Int Delay, s/veh	1.9

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	8	77	372	8	27	164
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	10	10	4	4	5	5
Mvmt Flow	9	86	413	9	30	182

Major/Minor	Minor1			Major1		Major2	
Conflicting Flow All	660	418		0	0	422	0
Stage 1	418	-		-	-	-	-
Stage 2	242	-		-	-	-	-
Critical Hdwy	6.5	6.3		-	-	4.15	-
Critical Hdwy Stg 1	5.5	-		-	-	-	-
Critical Hdwy Stg 2	5.5	-		-	-	-	-
Follow-up Hdwy	3.59	3.39		-	-	2.245	-
Pot Cap-1 Maneuver	416	618		-	-	1121	-
Stage 1	647	-		-	-	-	-
Stage 2	780	-		-	-	-	-
Platoon blocked, %				-	-		-
Mov Cap-1 Maneuver	404	618		-	-	1121	-
Mov Cap-2 Maneuver	404	-		-	-	-	-
Stage 1	647	-		-	-	-	-
Stage 2	757	-		-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	12.3		1.2
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	589	1121	-
HCM Lane V/C Ratio	-	-	0.16	0.027	-
HCM Control Delay (s)	-	-	12.3	8.3	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	1	0	-

F-4196

Intersection

Int Delay, s/veh	1.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	35	155	144	94	345	113
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	None
Storage Length	0	100	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	6	6	10	10	11	11
Mvmt Flow	39	172	160	104	383	126

Major/Minor	Minor1			Major1		Major2	
Conflicting Flow All	1104	-		0	0	264	0
Stage 1	212	-		-	-	-	-
Stage 2	892	-		-	-	-	-
Critical Hdwy	6.46	-		-	-	4.21	-
Critical Hdwy Stg 1	5.46	-		-	-	-	-
Critical Hdwy Stg 2	5.46	-		-	-	-	-
Follow-up Hdwy	3.554	-		-	-	2.299	-
Pot Cap-1 Maneuver	229	0		-	-	1250	-
Stage 1	814	0		-	-	-	-
Stage 2	394	0		-	-	-	-
Platoon blocked, %				-	-		-
Mov Cap-1 Maneuver	159	-		-	-	1250	-
Mov Cap-2 Maneuver	159	-		-	-	-	-
Stage 1	814	-		-	-	-	-
Stage 2	273	-		-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	34.8		
HCM LOS	D		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	159	-	1250	-
HCM Lane V/C Ratio	-	-	0.245	-	0.307	-
HCM Control Delay (s)	-	-	34.8	0	9.1	-
HCM Lane LOS	-	-	D	A	A	-
HCM 95th %tile Q(veh)	-	-	1	-	1	-

F-4197

Intersection

Int Delay, s/veh	2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	68	428	95	77	107	153
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	None
Storage Length	0	100	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	5	5	9	9	9	9
Mvmt Flow	76	476	106	86	119	170

Major/Minor	Minor1			Major1		Major2	
Conflicting Flow All	556	-		0	0	191	0
Stage 1	148	-		-	-	-	-
Stage 2	408	-		-	-	-	-
Critical Hdwy	6.45	-		-	-	4.19	-
Critical Hdwy Stg 1	5.45	-		-	-	-	-
Critical Hdwy Stg 2	5.45	-		-	-	-	-
Follow-up Hdwy	3.545	-		-	-	2.281	-
Pot Cap-1 Maneuver	487	0		-	-	1342	-
Stage 1	872	0		-	-	-	-
Stage 2	665	0		-	-	-	-
Platoon blocked, %				-	-		-
Mov Cap-1 Maneuver	444	-		-	-	1342	-
Mov Cap-2 Maneuver	444	-		-	-	-	-
Stage 1	872	-		-	-	-	-
Stage 2	606	-		-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	14.8		
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	444	-	1342	-
HCM Lane V/C Ratio	-	-	0.17	-	0.089	-
HCM Control Delay (s)	-	-	14.8	0	7.9	-
HCM Lane LOS	-	-	B	A	A	-
HCM 95th %tile Q(veh)	-	-	1	-	0	-

F-4198

Intersection

Int Delay, s/veh	4.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	121	80	54	220	368	69
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	11	11	15	15
Mvmt Flow	134	89	60	244	409	77

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	689	243	486	0	-	0
Stage 1	447	-	-	-	-	-
Stage 2	242	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.32	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.31	-	-	-
Pot Cap-1 Maneuver	380	758	1012	-	-	-
Stage 1	611	-	-	-	-	-
Stage 2	776	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	357	758	1012	-	-	-
Mov Cap-2 Maneuver	357	-	-	-	-	-
Stage 1	611	-	-	-	-	-
Stage 2	730	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	20.5		
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1012	-	452	-	-
HCM Lane V/C Ratio	0.059	-	0.494	-	-
HCM Control Delay (s)	8.8	-	20.5	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0	-	3	-	-

F-4199

Intersection

Int Delay, s/veh	3.6

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	109	47	110	521	207	100
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	9	9	12	12
Mvmt Flow	121	52	122	579	230	111

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	820	171	341	0	-	0
Stage 1	286	-	-	-	-	-
Stage 2	534	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.28	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.29	-	-	-
Pot Cap-1 Maneuver	313	843	1166	-	-	-
Stage 1	737	-	-	-	-	-
Stage 2	552	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	280	843	1166	-	-	-
Mov Cap-2 Maneuver	280	-	-	-	-	-
Stage 1	737	-	-	-	-	-
Stage 2	494	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	24.9		
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1166	-	351	-	-
HCM Lane V/C Ratio	0.105	-	0.494	-	-
HCM Control Delay (s)	8.4	-	24.9	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0	-	3	-	-

F-4200

Intersection

Int Delay, s/veh	16.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	398	255	0	367	231	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	350	0	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	11	11	15	15	16	16
Mvmt Flow	442	283	0	408	257	0

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	461	128	257	0	-	0
Stage 1	257	-	-	-	-	-
Stage 2	204	-	-	-	-	-
Critical Hdwy	7.02	7.12	4.4	-	-	-
Critical Hdwy Stg 1	6.02	-	-	-	-	-
Critical Hdwy Stg 2	6.02	-	-	-	-	-
Follow-up Hdwy	3.61	3.41	2.35	-	-	-
Pot Cap-1 Maneuver	507	870	1215	-	-	-
Stage 1	736	-	-	-	-	-
Stage 2	784	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	507	870	1215	-	-	-
Mov Cap-2 Maneuver	507	-	-	-	-	-
Stage 1	736	-	-	-	-	-
Stage 2	784	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	30.8		
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1215	-	507	870	-	-
HCM Lane V/C Ratio	-	-	0.872	0.326	-	-
HCM Control Delay (s)	0	-	43.5	11.1	-	-
HCM Lane LOS	A	-	E	B	-	-
HCM 95th %tile Q(veh)	0	-	9	1	-	-

F-4201

Intersection

Int Delay, s/veh	2.7

Movement	EBL	EBR	NBL	NBT		SBT	SBR
Vol, veh/h	98	87	0	538		172	0
Conflicting Peds, #/hr	0	0	0	0		0	0
Sign Control	Stop	Stop	Free	Free		Free	Free
RT Channelized	-	None	-	None		-	None
Storage Length	350	0	-	-		-	-
Veh in Median Storage, #	0	-	-	0		0	-
Grade, %	0	-	-	0		0	-
Peak Hour Factor	90	90	90	90		90	90
Heavy Vehicles, %	33	33	12	12		17	17
Mvmt Flow	109	97	0	598		191	0

Major/Minor	Minor2			Major1		Major2	
Conflicting Flow All	490	96	191	0		-	0
Stage 1	191	-	-	-		-	-
Stage 2	299	-	-	-		-	-
Critical Hdwy	7.46	7.56	4.34	-		-	-
Critical Hdwy Stg 1	6.46	-	-	-		-	-
Critical Hdwy Stg 2	6.46	-	-	-		-	-
Follow-up Hdwy	3.83	3.63	2.32	-		-	-
Pot Cap-1 Maneuver	437	851	1310	-		-	-
Stage 1	737	-	-	-		-	-
Stage 2	642	-	-	-		-	-
Platoon blocked, %				-		-	-
Mov Cap-1 Maneuver	437	851	1310	-		-	-
Mov Cap-2 Maneuver	437	-	-	-		-	-
Stage 1	737	-	-	-		-	-
Stage 2	642	-	-	-		-	-

Approach	EB	NB	SB
HCM Control Delay, s	13.1		
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1310	-	437	851	-	-
HCM Lane V/C Ratio	-	-	0.249	0.114	-	-
HCM Control Delay (s)	0	-	16	9.8	-	-
HCM Lane LOS	A	-	C	A	-	-
HCM 95th %tile Q(veh)	0	-	1	0	-	-

F-4202

Intersection

Int Delay, s/veh	0

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	78	687	231	62
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	225	-	-	325
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	16	16	25	25
Mvmt Flow	0	0	87	763	257	69

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	812	128	257	0	-	0
Stage 1	257	-	-	-	-	-
Stage 2	555	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.42	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.36	-	-	-
Pot Cap-1 Maneuver	317	898	1209	-	-	-
Stage 1	762	-	-	-	-	-
Stage 2	539	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	294	898	1209	-	-	-
Mov Cap-2 Maneuver	294	-	-	-	-	-
Stage 1	762	-	-	-	-	-
Stage 2	500	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0		
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1209	-	-	-	-
HCM Lane V/C Ratio	0.072	-	-	-	-
HCM Control Delay (s)	8.2	-	0	-	-
HCM Lane LOS	A	-	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-

F-4203

Intersection

Int Delay, s/veh	0

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	283	353	172	547
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	225	-	-	325
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	17	17	19	19
Mvmt Flow	0	0	314	392	191	608

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1016	96	191	0	-	0
Stage 1	191	-	-	-	-	-
Stage 2	825	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.44	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.37	-	-	-
Pot Cap-1 Maneuver	234	942	1277	-	-	-
Stage 1	822	-	-	-	-	-
Stage 2	391	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	176	942	1277	-	-	-
Mov Cap-2 Maneuver	176	-	-	-	-	-
Stage 1	822	-	-	-	-	-
Stage 2	295	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0		
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1277	-	-	-	-
HCM Lane V/C Ratio	0.246	-	-	-	-
HCM Control Delay (s)	8.7	-	0	-	-
HCM Lane LOS	A	-	A	-	-
HCM 95th %tile Q(veh)	1	-	-	-	-

F-4204

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	⬈⬊⬊		⬉	⬆⬆	⬆⬆	⬈
Volume (veh/h)	418	65	184	393	833	929
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1776	1900	1810	1810	1845	1845
Adj Flow Rate, veh/h	531	0	204	437	926	1032
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	7	0	5	5	3	3
Cap, veh/h	602	287	186	2535	2584	1156
Arrive On Green	0.18	0.00	0.74	0.74	0.49	0.49
Sat Flow, veh/h	3382	1615	217	3529	3597	1568
Grp Volume(v), veh/h	531	0	204	437	926	1032
Grp Sat Flow(s),veh/h/ln	1691	1615	217	1719	1752	1568
Q Serve(g_s), s	18.1	0.0	67.8	4.5	19.2	70.3
Cycle Q Clear(g_c), s	18.1	0.0	87.0	4.5	19.2	70.3
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	602	287	186	2535	2584	1156
V/C Ratio(X)	0.88	0.00	1.10	0.17	0.36	0.89
Avail Cap(c_a), veh/h	717	342	186	2535	2584	1156
HCM Platoon Ratio	1.00	1.00	1.00	1.00	0.67	0.67
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.17	0.17
Uniform Delay (d), s/veh	47.3	0.0	36.2	4.7	12.7	25.6
Incr Delay (d2), s/veh	11.0	0.0	94.7	0.1	0.1	2.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.3	0.0	10.9	2.2	9.3	31.1
LnGrp Delay(d),s/veh	58.3	0.0	130.9	4.8	12.8	27.8
LnGrp LOS	E		F	A	B	C
Approach Vol, veh/h	531			641	1958	
Approach Delay, s/veh	58.3			44.9	20.7	
Approach LOS	E			D	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		93.0				93.0		27.0
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		83.0				83.0		25.0
Max Q Clear Time (g_c+I1), s		72.3				89.0		20.1
Green Ext Time (p_c), s		9.8				0.0		0.9

Intersection Summary	
HCM 2010 Ctrl Delay	32.0
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

F-4205

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↗↰↗		↰↗	↑↑	↑↑	↗
Volume (veh/h)	584	119	185	583	683	618
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1900	1827	1827	1845	1845
Adj Flow Rate, veh/h	772	0	206	648	759	687
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	0	4	4	3	3
Cap, veh/h	879	408	309	2263	2285	1022
Arrive On Green	0.25	0.00	0.65	0.65	1.00	1.00
Sat Flow, veh/h	3480	1615	360	3563	3597	1568
Grp Volume(v), veh/h	772	0	206	648	759	687
Grp Sat Flow(s),veh/h/ln	1740	1615	360	1736	1752	1568
Q Serve(g_s), s	20.7	0.0	45.3	7.8	0.0	0.0
Cycle Q Clear(g_c), s	20.7	0.0	45.3	7.8	0.0	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	879	408	309	2263	2285	1022
V/C Ratio(X)	0.88	0.00	0.67	0.29	0.33	0.67
Avail Cap(c_a), veh/h	1073	498	309	2263	2285	1022
HCM Platoon Ratio	1.00	1.00	1.00	1.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.42	0.42
Uniform Delay (d), s/veh	34.9	0.0	13.8	7.2	0.0	0.0
Incr Delay (d2), s/veh	7.3	0.0	10.9	0.3	0.2	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	10.9	0.0	5.3	3.8	0.1	0.4
LnGrp Delay(d),s/veh	42.2	0.0	24.7	7.6	0.2	1.5
LnGrp LOS	D		C	A	A	A
Approach Vol, veh/h	772			854	1446	
Approach Delay, s/veh	42.2			11.7	0.8	
Approach LOS	D			B	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		69.4				69.4		30.6
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		58.0				58.0		30.0
Max Q Clear Time (g_c+I1), s		2.0				47.3		22.7
Green Ext Time (p_c), s		29.3				8.9		1.8

Intersection Summary	
HCM 2010 Ctrl Delay	14.2
HCM 2010 LOS	B

Notes

User approved volume balancing among the lanes for turning movement.

F-4206

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	⬆️⬆️		⬆️	⬆️⬆️	⬆️⬆️	⬆️
Volume (veh/h)	559	307	104	707	1455	615
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1696	1900	1845	1845	1827	1827
Adj Flow Rate, veh/h	621	0	116	786	1617	683
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	12	0	3	3	4	4
Cap, veh/h	712	356	236	2515	2038	912
Arrive On Green	0.22	0.00	0.16	1.00	0.59	0.59
Sat Flow, veh/h	3231	1615	1757	3597	3563	1553
Grp Volume(v), veh/h	621	0	116	786	1617	683
Grp Sat Flow(s),veh/h/ln	1616	1615	1757	1752	1736	1553
Q Serve(g_s), s	21.4	0.0	2.5	0.0	41.5	37.3
Cycle Q Clear(g_c), s	21.4	0.0	2.5	0.0	41.5	37.3
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	712	356	236	2515	2038	912
V/C Ratio(X)	0.87	0.00	0.49	0.31	0.79	0.75
Avail Cap(c_a), veh/h	982	491	236	2515	2038	912
HCM Platoon Ratio	1.00	1.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.82	0.82	1.00	1.00
Uniform Delay (d), s/veh	43.4	0.0	20.9	0.0	18.4	17.5
Incr Delay (d2), s/veh	6.6	0.0	1.3	0.3	3.3	5.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	10.2	0.0	2.1	0.1	20.7	17.4
LnGrp Delay(d),s/veh	49.9	0.0	22.2	0.3	21.6	23.1
LnGrp LOS	D		C	A	C	C
Approach Vol, veh/h	621			902	2300	
Approach Delay, s/veh	49.9			3.1	22.1	
Approach LOS	D			A	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	15.0	73.6				88.6		31.4
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	9.0	58.0				73.0		35.0
Max Q Clear Time (g_c+I1), s	4.5	43.5				2.0		23.4
Green Ext Time (p_c), s	0.1	13.1				46.7		2.0

Intersection Summary	
HCM 2010 Ctrl Delay	22.1
HCM 2010 LOS	C

Notes	
User approved volume balancing among the lanes for turning movement.

F-4207

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↱↟↰		↰	↟↟	↟↟	↱
Volume (veh/h)	760	268	66	1101	1033	523
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1743	1900	1845	1845	1827	1827
Adj Flow Rate, veh/h	844	0	73	1223	1148	581
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	9	0	3	3	4	4
Cap, veh/h	970	472	300	2207	1640	734
Arrive On Green	0.29	0.00	0.13	0.84	0.47	0.47
Sat Flow, veh/h	3320	1615	1757	3597	3563	1553
Grp Volume(v), veh/h	844	0	73	1223	1148	581
Grp Sat Flow(s),veh/h/ln	1660	1615	1757	1752	1736	1553
Q Serve(g_s), s	23.0	0.0	1.7	10.1	24.9	30.1
Cycle Q Clear(g_c), s	23.0	0.0	1.7	10.1	24.9	30.1
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	970	472	300	2207	1640	734
V/C Ratio(X)	0.87	0.00	0.24	0.55	0.70	0.79
Avail Cap(c_a), veh/h	1287	626	300	2207	1640	734
HCM Platoon Ratio	1.00	1.00	1.33	1.33	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.76	0.76	1.00	1.00
Uniform Delay (d), s/veh	32.1	0.0	13.1	3.7	19.8	21.2
Incr Delay (d2), s/veh	5.2	0.0	0.3	0.8	2.5	8.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	11.3	0.0	0.8	4.8	12.4	14.5
LnGrp Delay(d),s/veh	37.3	0.0	13.4	4.5	22.3	29.8
LnGrp LOS	D		B	A	C	C
Approach Vol, veh/h	844			1296	1729	
Approach Delay, s/veh	37.3			5.0	24.8	
Approach LOS	D			A	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	15.0	51.1				66.1		33.9
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	9.0	36.0				51.0		37.0
Max Q Clear Time (g_c+I1), s	3.7	32.1				12.1		25.0
Green Ext Time (p_c), s	0.1	3.7				28.9		2.9

Intersection Summary	
HCM 2010 Ctrl Delay	20.9
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

F-4208

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↑↑↓		↱	↑↑	↱		↰	↱	↱	↑↓	
Volume (veh/h)	31	776	213	29	733	222	36	12	123	12	5	58
Number	1	6	16	5	2	12	7	4	14	3	8	18
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1900	1827	1827	1827	1900	1776	1776	1845	1845	1900
Adj Flow Rate, veh/h	34	862	237	32	814	247	40	13	137	13	6	64
Adj No. of Lanes	1	2	0	1	2	1	0	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	4	4	4	7	7	7	3	3	3
Cap, veh/h	342	1555	427	300	2024	906	302	85	359	331	32	345
Arrive On Green	0.58	0.58	0.58	0.58	0.58	0.58	0.24	0.24	0.24	0.24	0.24	0.24
Sat Flow, veh/h	515	2667	733	501	3471	1553	874	357	1509	1220	136	1452
Grp Volume(v), veh/h	34	555	544	32	814	247	53	0	137	13	0	70
Grp Sat Flow(s),veh/h/ln	515	1719	1680	501	1736	1553	1231	0	1509	1220	0	1588
Q Serve(g_s), s	2.6	13.3	13.3	2.8	8.5	5.3	1.3	0.0	5.1	0.6	0.0	2.4
Cycle Q Clear(g_c), s	11.1	13.3	13.3	16.2	8.5	5.3	3.6	0.0	5.1	4.2	0.0	2.4
Prop In Lane	1.00		0.44	1.00		1.00	0.75		1.00	1.00		0.91
Lane Grp Cap(c), veh/h	342	1002	980	300	2024	906	387	0	359	331	0	377
V/C Ratio(X)	0.10	0.55	0.55	0.11	0.40	0.27	0.14	0.00	0.38	0.04	0.00	0.19
Avail Cap(c_a), veh/h	472	1438	1406	427	2905	1299	511	0	496	443	0	522
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	10.6	8.6	8.6	13.6	7.6	6.9	20.9	0.0	21.4	22.6	0.0	20.3
Incr Delay (d2), s/veh	0.1	0.5	0.5	0.2	0.1	0.2	0.2	0.0	0.7	0.0	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	6.3	6.2	0.4	4.1	2.2	0.8	0.0	2.2	0.2	0.0	1.1
LnGrp Delay(d),s/veh	10.8	9.1	9.1	13.7	7.7	7.1	21.1	0.0	22.1	22.6	0.0	20.6
LnGrp LOS	B	A	A	B	A	A	C		C	C		C
Approach Vol, veh/h		1133			1093			190			83	
Approach Delay, s/veh		9.1			7.8			21.8			20.9	
Approach LOS		A			A			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		45.0		21.9		45.0		21.9
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		56.0		22.0		56.0		22.0
Max Q Clear Time (g_c+I1), s		18.2		7.1		15.3		6.2
Green Ext Time (p_c), s		20.9		1.0		21.7		1.1

Intersection Summary	
HCM 2010 Ctrl Delay	9.9
HCM 2010 LOS	A

F-4209

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↑↑⤵		↱	↑↑	↱		↰↱	↱	↱	↑⤵	
Volume (veh/h)	68	770	182	52	651	240	75	11	127	20	14	36
Number	1	6	16	5	2	12	7	4	14	3	8	18
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1900	1827	1827	1827	1900	1827	1827	1845	1845	1900
Adj Flow Rate, veh/h	76	856	202	58	723	267	83	12	141	22	16	40
Adj No. of Lanes	1	2	0	1	2	1	0	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	4	4	4	4	4	4	3	3	3
Cap, veh/h	372	1633	385	316	2033	910	350	44	367	297	111	277
Arrive On Green	0.59	0.59	0.59	0.59	0.59	0.59	0.24	0.24	0.24	0.24	0.24	0.24
Sat Flow, veh/h	555	2789	658	521	3471	1553	1056	186	1553	1217	468	1170
Grp Volume(v), veh/h	76	533	525	58	723	267	95	0	141	22	0	56
Grp Sat Flow(s),veh/h/ln	555	1736	1711	521	1736	1553	1242	0	1553	1217	0	1638
Q Serve(g_s), s	5.6	12.4	12.4	5.1	7.4	5.8	3.6	0.0	5.1	1.0	0.0	1.8
Cycle Q Clear(g_c), s	13.0	12.4	12.4	17.4	7.4	5.8	5.4	0.0	5.1	6.4	0.0	1.8
Prop In Lane	1.00		0.38	1.00		1.00	0.87		1.00	1.00		0.71
Lane Grp Cap(c), veh/h	372	1017	1002	316	2033	910	393	0	367	297	0	387
V/C Ratio(X)	0.20	0.52	0.52	0.18	0.36	0.29	0.24	0.00	0.38	0.07	0.00	0.14
Avail Cap(c_a), veh/h	507	1440	1420	443	2880	1288	516	0	506	406	0	534
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	10.7	8.4	8.4	13.6	7.3	7.0	22.2	0.0	21.6	24.5	0.0	20.4
Incr Delay (d2), s/veh	0.3	0.4	0.4	0.3	0.1	0.2	0.3	0.0	0.7	0.1	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	5.9	5.8	0.7	3.5	2.5	1.5	0.0	2.3	0.4	0.0	0.8
LnGrp Delay(d),s/veh	11.0	8.8	8.8	13.8	7.4	7.2	22.5	0.0	22.3	24.6	0.0	20.5
LnGrp LOS	B	A	A	B	A	A	C		C	C		C
Approach Vol, veh/h		1134			1048			236			78	
Approach Delay, s/veh		8.9			7.7			22.4			21.7	
Approach LOS		A			A			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		45.5		22.0		45.5		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		56.0		22.0		56.0		22.0
Max Q Clear Time (g_c+I1), s		19.4		7.4		15.0		8.4
Green Ext Time (p_c), s		20.1		1.2		21.3		1.2

Intersection Summary	
HCM 2010 Ctrl Delay	10.1
HCM 2010 LOS	B

F-4210

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↱		↰↰	↑↑↱		↰	↑↑↑	↱
Volume (veh/h)	19	29	228	80	7	9	498	992	169	18	902	47
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1792	1792	1792	1597	1597	1900	1810	1810	1900	1810	1810	1810
Adj Flow Rate, veh/h	21	32	253	89	8	10	553	1102	188	20	1002	52
Adj No. of Lanes	1	1	1	1	1	0	2	3	0	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	6	6	19	19	19	5	5	5	5	5	5
Cap, veh/h	362	377	320	277	136	170	682	2179	372	70	1727	538
Arrive On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.51	0.51	0.04	0.35	0.35
Sat Flow, veh/h	1337	1792	1524	934	646	808	3343	4250	725	1723	4940	1538
Grp Volume(v), veh/h	21	32	253	89	0	18	553	854	436	20	1002	52
Grp Sat Flow(s),veh/h/ln	1337	1792	1524	934	0	1454	1672	1647	1682	1723	1647	1538
Q Serve(g_s), s	1.0	1.1	12.0	6.5	0.0	0.8	12.0	13.0	13.0	0.9	12.6	1.7
Cycle Q Clear(g_c), s	1.7	1.1	12.0	7.5	0.0	0.8	12.0	13.0	13.0	0.9	12.6	1.7
Prop In Lane	1.00		1.00	1.00		0.56	1.00		0.43	1.00		1.00
Lane Grp Cap(c), veh/h	362	377	320	277	0	305	682	1689	862	70	1727	538
V/C Ratio(X)	0.06	0.08	0.79	0.32	0.00	0.06	0.81	0.51	0.51	0.28	0.58	0.10
Avail Cap(c_a), veh/h	397	424	360	302	0	344	1054	1946	994	204	1946	606
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	24.7	24.2	28.5	27.2	0.0	24.1	28.9	12.2	12.2	35.4	20.2	16.7
Incr Delay (d2), s/veh	0.1	0.1	10.2	0.7	0.0	0.1	2.8	0.2	0.5	2.2	0.3	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.6	5.9	1.7	0.0	0.3	5.8	5.9	6.0	0.4	5.7	0.7
LnGrp Delay(d),s/veh	24.8	24.3	38.7	27.9	0.0	24.1	31.7	12.4	12.7	37.6	20.5	16.7
LnGrp LOS	C	C	D	C		C	C	B	B	D	C	B
Approach Vol, veh/h		306			107			1843			1074	
Approach Delay, s/veh		36.2			27.3			18.3			20.7	
Approach LOS		D			C			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	21.5	32.6		22.0	9.1	45.0		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	24.0	30.0		18.0	9.0	45.0		18.0
Max Q Clear Time (g_c+I1), s	14.0	14.6		9.5	2.9	15.0		14.0
Green Ext Time (p_c), s	1.5	12.0		1.1	0.0	19.8		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	21.0
HCM 2010 LOS	C

F-4211

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑	↱	↰	↱		↰↰	↑↑↱		↰	↑↑↑	↱
Volume (veh/h)	45	4	443	186	12	10	268	965	74	5	851	29
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1624	1624	1900	1827	1827	1900	1827	1827	1827
Adj Flow Rate, veh/h	50	4	492	207	13	11	298	1072	82	6	946	32
Adj No. of Lanes	1	1	1	1	1	0	2	3	0	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	17	17	17	4	4	4	4	4	4
Cap, veh/h	554	643	546	361	281	238	392	1946	149	24	1544	481
Arrive On Green	0.35	0.35	0.35	0.35	0.35	0.35	0.12	0.41	0.41	0.01	0.31	0.31
Sat Flow, veh/h	1381	1863	1583	783	814	689	3375	4727	361	1740	4988	1553
Grp Volume(v), veh/h	50	4	492	207	0	24	298	754	400	6	946	32
Grp Sat Flow(s),veh/h/ln	1381	1863	1583	783	0	1502	1688	1663	1763	1740	1663	1553
Q Serve(g_s), s	2.0	0.1	23.2	18.5	0.0	0.8	6.7	13.5	13.6	0.3	12.7	1.1
Cycle Q Clear(g_c), s	2.8	0.1	23.2	18.6	0.0	0.8	6.7	13.5	13.6	0.3	12.7	1.1
Prop In Lane	1.00		1.00	1.00		0.46	1.00		0.20	1.00		1.00
Lane Grp Cap(c), veh/h	554	643	546	361	0	519	392	1368	726	24	1544	481
V/C Ratio(X)	0.09	0.01	0.90	0.57	0.00	0.05	0.76	0.55	0.55	0.25	0.61	0.07
Avail Cap(c_a), veh/h	622	735	625	400	0	593	559	1368	726	199	1779	554
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	18.0	16.9	24.4	23.0	0.0	17.1	33.6	17.6	17.6	38.3	23.1	19.1
Incr Delay (d2), s/veh	0.1	0.0	14.9	1.6	0.0	0.0	3.8	0.5	0.9	5.1	0.5	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	0.1	12.3	4.1	0.0	0.4	3.4	6.3	6.7	0.2	5.9	0.5
LnGrp Delay(d),s/veh	18.1	16.9	39.3	24.6	0.0	17.1	37.4	18.1	18.5	43.4	23.6	19.2
LnGrp LOS	B	B	D	C		B	D	B	B	D	C	B
Approach Vol, veh/h		546			231			1452			984	
Approach Delay, s/veh		37.2			23.8			22.2			23.6	
Approach LOS		D			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	15.1	30.3		33.1	7.1	38.3		33.1
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	13.0	28.0		31.0	9.0	32.0		31.0
Max Q Clear Time (g_c+I1), s	8.7	14.7		20.6	2.3	15.6		25.2
Green Ext Time (p_c), s	0.4	9.6		2.7	0.0	11.8		1.9

Intersection Summary	
HCM 2010 Ctrl Delay	25.3
HCM 2010 LOS	C

F-4212

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				⬏⬏		↗	⬏⬏	↑↑↑			↑↑↑	↗
Volume (veh/h)	0	0	0	475	0	296	235	1363	0	0	1073	137
Number				3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				1727	0	1727	1776	1776	0	0	1810	1810
Adj Flow Rate, veh/h				528	0	329	261	1514	0	0	1192	152
Adj No. of Lanes				2	0	1	2	3	0	0	3	1
Peak Hour Factor				0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %				10	0	10	7	7	0	0	5	5
Cap, veh/h				845	0	389	373	2826	0	0	1942	605
Arrive On Green				0.26	0.00	0.26	0.11	0.58	0.00	0.00	0.39	0.39
Sat Flow, veh/h				3191	0	1468	3281	5007	0	0	5103	1538
Grp Volume(v), veh/h				528	0	329	261	1514	0	0	1192	152
Grp Sat Flow(s),veh/h/ln				1596	0	1468	1640	1616	0	0	1647	1538
Q Serve(g_s), s				11.5	0.0	16.7	6.0	14.9	0.0	0.0	15.2	5.2
Cycle Q Clear(g_c), s				11.5	0.0	16.7	6.0	14.9	0.0	0.0	15.2	5.2
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				845	0	389	373	2826	0	0	1942	605
V/C Ratio(X)				0.62	0.00	0.85	0.70	0.54	0.00	0.00	0.61	0.25
Avail Cap(c_a), veh/h				1092	0	503	499	3134	0	0	2067	643
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	1.00	0.00	0.00	1.00	1.00
Uniform Delay (d), s/veh				25.5	0.0	27.5	33.7	10.0	0.0	0.0	19.1	16.1
Incr Delay (d2), s/veh				0.8	0.0	10.2	2.8	0.2	0.0	0.0	0.5	0.2
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				5.1	0.0	7.9	2.9	6.6	0.0	0.0	6.9	2.3
LnGrp Delay(d),s/veh				26.3	0.0	37.6	36.4	10.1	0.0	0.0	19.6	16.3
LnGrp LOS				C		D	D	B			B	B
Approach Vol, veh/h					857			1775			1344	
Approach Delay, s/veh					30.6			14.0			19.3	
Approach LOS					C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2			5	6		8
Phs Duration (G+Y+Rc), s		52.0			15.0	37.0		26.9
Change Period (Y+Rc), s		6.0			6.0	6.0		6.0
Max Green Setting (Gmax), s		51.0			12.0	33.0		27.0
Max Q Clear Time (g_c+I1), s		16.9			8.0	17.2		18.7
Green Ext Time (p_c), s		26.4			0.3	13.8		2.2

Intersection Summary	
HCM 2010 Ctrl Delay	19.4
HCM 2010 LOS	B

F-4213

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				⬏⬏		⬀	⬏⬏	⬆⬆⬆			⬆⬆⬆	⬀
Volume (veh/h)	0	0	0	608	0	254	531	1053	0	0	1251	229
Number				3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				1759	0	1759	1810	1810	0	0	1827	1827
Adj Flow Rate, veh/h				676	0	282	590	1170	0	0	1390	254
Adj No. of Lanes				2	0	1	2	3	0	0	3	1
Peak Hour Factor				0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %				8	0	8	5	5	0	0	4	4
Cap, veh/h				769	0	354	672	3082	0	0	1761	548
Arrive On Green				0.24	0.00	0.24	0.20	0.62	0.00	0.00	0.35	0.35
Sat Flow, veh/h				3250	0	1495	3343	5103	0	0	5152	1553
Grp Volume(v), veh/h				676	0	282	590	1170	0	0	1390	254
Grp Sat Flow(s),veh/h/ln				1625	0	1495	1672	1647	0	0	1663	1553
Q Serve(g_s), s				17.2	0.0	15.3	14.7	10.0	0.0	0.0	21.5	10.9
Cycle Q Clear(g_c), s				17.2	0.0	15.3	14.7	10.0	0.0	0.0	21.5	10.9
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				769	0	354	672	3082	0	0	1761	548
V/C Ratio(X)				0.88	0.00	0.80	0.88	0.38	0.00	0.00	0.79	0.46
Avail Cap(c_a), veh/h				831	0	382	738	3216	0	0	1797	560
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	1.00	0.00	0.00	1.00	1.00
Uniform Delay (d), s/veh				31.6	0.0	30.9	33.3	8.0	0.0	0.0	25.0	21.5
Incr Delay (d2), s/veh				10.1	0.0	10.5	10.9	0.1	0.0	0.0	2.4	0.6
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				8.8	0.0	7.3	7.8	4.6	0.0	0.0	10.2	4.7
LnGrp Delay(d),s/veh				41.8	0.0	41.4	44.3	8.1	0.0	0.0	27.4	22.1
LnGrp LOS				D		D	D	A			C	C
Approach Vol, veh/h					958			1760			1644	
Approach Delay, s/veh					41.7			20.2			26.6	
Approach LOS					D			C			C	

Timer	1	2	3	4	5	6	7	8				
Assigned Phs		2			5	6		8				
Phs Duration (G+Y+Rc), s		59.7			23.3	36.4		26.4				
Change Period (Y+Rc), s		6.0			6.0	6.0		6.0				
Max Green Setting (Gmax), s		56.0			19.0	31.0		22.0				
Max Q Clear Time (g_c+I1), s		12.0			16.7	23.5		19.2				
Green Ext Time (p_c), s		30.8			0.6	6.9		1.1				

Intersection Summary	
HCM 2010 Ctrl Delay	27.3
HCM 2010 LOS	C

F-4214

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⬱	↱	↰	⬳		↱	↑	↱		⬱⬳	
Volume (veh/h)	8	75	321	110	38	8	238	336	213	13	181	30
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1827	1827	1827	1827	1900	1776	1776	1776	1900	1810	1900
Adj Flow Rate, veh/h	9	83	357	122	42	9	264	373	237	14	201	33
Adj No. of Lanes	0	1	1	1	1	0	1	1	1	0	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	4	4	4	7	7	7	5	5	5
Cap, veh/h	66	393	583	452	600	129	500	770	654	67	572	91
Arrive On Green	0.23	0.23	0.23	0.11	0.41	0.41	0.15	0.43	0.43	0.21	0.21	0.21
Sat Flow, veh/h	64	1738	1553	1740	1459	313	1691	1776	1509	74	2766	441
Grp Volume(v), veh/h	92	0	357	122	0	51	264	373	237	131	0	117
Grp Sat Flow(s),veh/h/ln	1802	0	1553	1740	0	1772	1691	1776	1509	1713	0	1569
Q Serve(g_s), s	0.0	0.0	14.4	3.7	0.0	1.3	8.8	11.7	8.2	0.0	0.0	5.0
Cycle Q Clear(g_c), s	3.2	0.0	14.4	3.7	0.0	1.3	8.8	11.7	8.2	4.8	0.0	5.0
Prop In Lane	0.10		1.00	1.00		0.18	1.00		1.00	0.11		0.28
Lane Grp Cap(c), veh/h	458	0	583	452	0	729	500	770	654	406	0	324
V/C Ratio(X)	0.20	0.00	0.61	0.27	0.00	0.07	0.53	0.48	0.36	0.32	0.00	0.36
Avail Cap(c_a), veh/h	561	0	673	602	0	985	948	1492	1268	631	0	547
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	24.4	0.0	19.6	17.3	0.0	13.8	17.9	15.7	14.7	26.2	0.0	26.3
Incr Delay (d2), s/veh	0.2	0.0	1.3	0.3	0.0	0.0	0.9	0.5	0.3	0.5	0.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.6	0.0	6.4	1.8	0.0	0.7	4.2	5.8	3.4	2.4	0.0	2.2
LnGrp Delay(d),s/veh	24.6	0.0	20.9	17.6	0.0	13.8	18.8	16.2	15.1	26.7	0.0	27.0
LnGrp LOS	C		C	B		B	B	B	B	C		C
Approach Vol, veh/h		449			173			874			248	
Approach Delay, s/veh		21.7			16.5			16.7			26.8	
Approach LOS		C			B			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		39.5	14.3	23.5	17.5	22.0		37.8
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		65.0	15.0	22.0	32.0	27.0		43.0
Max Q Clear Time (g_c+I1), s		13.7	5.7	16.4	10.8	7.0		3.3
Green Ext Time (p_c), s		5.1	0.2	1.1	0.7	4.5		2.1

Intersection Summary	
HCM 2010 Ctrl Delay	19.4
HCM 2010 LOS	B

F-4215

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↵	↱	↰	↱		↱	↑	↱		↵↱	
Volume (veh/h)	18	53	390	185	64	6	260	250	166	4	316	29
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1845	1845	1845	1845	1900	1810	1810	1810	1900	1827	1900
Adj Flow Rate, veh/h	20	59	433	206	71	7	289	278	184	4	351	32
Adj No. of Lanes	0	1	1	1	1	0	1	1	1	0	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	3	3	3	5	5	5	4	4	4
Cap, veh/h	123	323	603	460	685	68	460	787	669	48	630	57
Arrive On Green	0.23	0.23	0.23	0.11	0.41	0.41	0.16	0.44	0.44	0.20	0.20	0.20
Sat Flow, veh/h	294	1428	1568	1757	1653	163	1723	1810	1538	9	3138	283
Grp Volume(v), veh/h	79	0	433	206	0	78	289	278	184	204	0	183
Grp Sat Flow(s),veh/h/ln	1722	0	1568	1757	0	1816	1723	1810	1538	1817	0	1613
Q Serve(g_s), s	0.0	0.0	18.0	6.7	0.0	2.1	9.9	8.2	6.1	0.0	0.0	8.1
Cycle Q Clear(g_c), s	2.8	0.0	18.0	6.7	0.0	2.1	9.9	8.2	6.1	8.0	0.0	8.1
Prop In Lane	0.25		1.00	1.00		0.09	1.00		1.00	0.02		0.18
Lane Grp Cap(c), veh/h	446	0	603	460	0	752	460	787	669	411	0	324
V/C Ratio(X)	0.18	0.00	0.72	0.45	0.00	0.10	0.63	0.35	0.27	0.50	0.00	0.56
Avail Cap(c_a), veh/h	446	0	603	658	0	957	878	1499	1274	681	0	567
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	24.9	0.0	20.8	18.4	0.0	14.3	19.0	15.0	14.4	28.6	0.0	28.7
Incr Delay (d2), s/veh	0.2	0.0	4.1	0.7	0.0	0.1	1.4	0.3	0.2	0.9	0.0	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.4	0.0	8.7	3.3	0.0	1.1	4.8	4.2	2.6	4.1	0.0	3.7
LnGrp Delay(d),s/veh	25.1	0.0	24.9	19.1	0.0	14.3	20.4	15.3	14.7	29.6	0.0	30.2
LnGrp LOS	C		C	B		B	C	B	B	C		C
Approach Vol, veh/h		512			284			751			387	
Approach Delay, s/veh		24.9			17.8			17.1			29.9	
Approach LOS		C			B			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		40.7	15.0	24.0	18.7	22.0		39.0
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		66.0	18.0	18.0	32.0	28.0		42.0
Max Q Clear Time (g_c+I1), s		10.2	8.7	20.0	11.9	10.1		4.1
Green Ext Time (p_c), s		5.1	0.4	0.0	0.8	4.3		2.6

Intersection Summary	
HCM 2010 Ctrl Delay	21.8
HCM 2010 LOS	C

F-4216

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↑↑			↑↑↱		↱↱		↱			
Volume (vph)	132	867	0	0	454	121	301	0	51	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0		6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95		0.97		1.00			
Frt	1.00	1.00			0.97		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1671	3343			3268		2943		1357			
Flt Permitted	0.34	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	594	3343			3268		2943		1357			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	147	963	0	0	504	134	334	0	57	0	0	0
RTOR Reduction (vph)	0	0	0	0	20	0	0	0	46	0	0	0
Lane Group Flow (vph)	147	963	0	0	618	0	334	0	11	0	0	0
Heavy Vehicles (%)	8%	8%	8%	7%	7%	7%	19%	19%	19%	2%	2%	2%
Turn Type	custom	NA			NA		Prot		Prot			
Protected Phases	5 8	2 5 8			6		7		7			
Permitted Phases	2						7		7			
Actuated Green, G (s)	73.2	73.2			45.2		22.7		22.7			
Effective Green, g (s)	73.2	73.2			45.2		22.7		22.7			
Actuated g/C Ratio	0.63	0.63			0.39		0.19		0.19			
Clearance Time (s)					6.0		6.0		6.0			
Vehicle Extension (s)					3.0		3.0		3.0			
Lane Grp Cap (vph)	657	2093			1263		571		263			
v/s Ratio Prot	0.06	c0.29			c0.19		c0.11		0.01			
v/s Ratio Perm	0.08											
v/c Ratio	0.22	0.46			0.49		0.58		0.04			
Uniform Delay, d1	9.3	11.5			27.1		42.8		38.3			
Progression Factor	0.96	0.84			1.00		1.00		1.00			
Incremental Delay, d2	0.1	0.1			0.3		1.5		0.1			
Delay (s)	9.0	9.7			27.4		44.4		38.3			
Level of Service	A	A			C		D		D			
Approach Delay (s)		9.6			27.4		43.5				0.0	
Approach LOS		A			C		D				A	

Intersection Summary				
HCM 2000 Control Delay	21.1	HCM 2000 Level of Service		C
HCM 2000 Volume to Capacity ratio	0.53			
Actuated Cycle Length (s)	116.9	Sum of lost time (s)		24.0
Intersection Capacity Utilization	76.5%	ICU Level of Service		D
Analysis Period (min)	15			

c   Critical Lane Group

F-4217

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↱	↑↑			↑↱		↰↰		↱			
Volume (vph)	257	623	0	0	748	295	309	0	105	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0		6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95		0.97		1.00			
Frt	1.00	1.00			0.96		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1703	3406			3292		3072		1417			
Flt Permitted	0.12	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	220	3406			3292		3072		1417			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	286	692	0	0	831	328	343	0	117	0	0	0
RTOR Reduction (vph)	0	0	0	0	35	0	0	0	100	0	0	0
Lane Group Flow (vph)	286	692	0	0	1124	0	343	0	17	0	0	0
Heavy Vehicles (%)	6%	6%	6%	5%	5%	5%	14%	14%	14%	2%	2%	2%
Turn Type	custom	NA			NA		Prot		Prot			
Protected Phases	5 8	2 5 8			6		7		7			
Permitted Phases	2						7		7			
Actuated Green, G (s)	74.2	74.2			49.6		17.1		17.1			
Effective Green, g (s)	74.2	74.2			49.6		17.1		17.1			
Actuated g/C Ratio	0.63	0.63			0.42		0.15		0.15			
Clearance Time (s)					6.0		6.0		6.0			
Vehicle Extension (s)					3.0		3.0		3.0			
Lane Grp Cap (vph)	548	2160			1395		448		207			
v/s Ratio Prot	c0.14	0.20			c0.34		c0.11		0.01			
v/s Ratio Perm	0.19											
v/c Ratio	0.52	0.32			0.81		0.77		0.08			
Uniform Delay, d1	18.3	9.8			29.5		48.0		43.2			
Progression Factor	2.25	0.77			1.00		1.00		1.00			
Incremental Delay, d2	0.7	0.1			3.5		7.6		0.2			
Delay (s)	41.9	7.7			33.0		55.7		43.3			
Level of Service	D	A			C		E		D			
Approach Delay (s)		17.7			33.0		52.5				0.0	
Approach LOS		B			C		D				A	

Intersection Summary				
HCM 2000 Control Delay	30.7	HCM 2000 Level of Service		C
HCM 2000 Volume to Capacity ratio	0.75			
Actuated Cycle Length (s)	117.0	Sum of lost time (s)		24.0
Intersection Capacity Utilization	68.2%	ICU Level of Service		C
Analysis Period (min)	15			

c   Critical Lane Group

F-4218

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↗	↰	↑↑					↰		↗
Volume (vph)	0	678	585	71	684	0	0	0	0	321	0	229
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					1.00		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3312	1482	1671	3343					1612		1442
Flt Permitted		1.00	1.00	0.22	1.00					0.95		1.00
Satd. Flow (perm)		3312	1482	386	3343					1612		1442
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	753	650	79	760	0	0	0	0	357	0	254
RTOR Reduction (vph)	0	0	132	0	0	0	0	0	0	0	0	88
Lane Group Flow (vph)	0	753	518	79	760	0	0	0	0	357	0	166
Heavy Vehicles (%)	9%	9%	9%	8%	8%	8%	2%	2%	2%	12%	12%	12%
Turn Type		NA	custom	custom	NA					custom		custom
Protected Phases		2		1	1 6					7 8		7 8
Permitted Phases			2 7 8	6						7 8		7 8
Actuated Green, G (s)		42.2	92.9	57.2	57.2					44.7		44.7
Effective Green, g (s)		42.2	92.9	57.2	57.2					44.7		44.7
Actuated g/C Ratio		0.36	0.79	0.49	0.49					0.38		0.38
Clearance Time (s)		6.0		6.0								
Vehicle Extension (s)		3.0		3.0								
Lane Grp Cap (vph)		1195	1177	320	1635					616		551
v/s Ratio Prot		c0.23		0.03	c0.23					c0.22		0.12
v/s Ratio Perm			0.35	0.10								
v/c Ratio		0.63	0.44	0.25	0.46					0.58		0.30
Uniform Delay, d1		30.9	3.8	17.6	19.7					28.6		25.2
Progression Factor		1.00	1.00	0.43	1.15					1.00		1.00
Incremental Delay, d2		1.1	0.3	0.4	0.2					1.3		0.3
Delay (s)		32.0	4.1	7.9	22.9					30.0		25.5
Level of Service		C	A	A	C					C		C
Approach Delay (s)		19.0			21.4			0.0			28.1	
Approach LOS		B			C			A			C	

Intersection Summary				
HCM 2000 Control Delay	21.7	HCM 2000 Level of Service	C	
HCM 2000 Volume to Capacity ratio	0.63			
Actuated Cycle Length (s)	116.9	Sum of lost time (s)	24.0	
Intersection Capacity Utilization	76.5%	ICU Level of Service	D	
Analysis Period (min)	15			

c   Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↑↑	↑↗	↖	↑↑					↖		↑↗
Volume (vph)	0	699	406	102	955	0	0	0	0	181	0	196
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					1.00		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3343	1495	1703	3406					1570		1404
Flt Permitted		1.00	1.00	0.19	1.00					0.95		1.00
Satd. Flow (perm)		3343	1495	345	3406					1570		1404
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	777	451	113	1061	0	0	0	0	201	0	218
RTOR Reduction (vph)	0	0	116	0	0	0	0	0	0	0	0	91
Lane Group Flow (vph)	0	777	335	113	1061	0	0	0	0	201	0	127
Heavy Vehicles (%)	8%	8%	8%	6%	6%	6%	2%	2%	2%	15%	15%	15%
Turn Type		NA	custom	custom	NA					custom		custom
Protected Phases		2		1	1 6					7 8		7 8
Permitted Phases			2 7 8	6						7 8		7 8
Actuated Green, G (s)		41.9	87.0	65.9	65.9					39.1		39.1
Effective Green, g (s)		41.9	87.0	65.9	65.9					39.1		39.1
Actuated g/C Ratio		0.36	0.74	0.56	0.56					0.33		0.33
Clearance Time (s)		6.0		6.0								
Vehicle Extension (s)		3.0		3.0								
Lane Grp Cap (vph)		1197	1111	403	1918					524		469
v/s Ratio Prot		c0.23		0.04	c0.31					c0.13		0.09
v/s Ratio Perm			0.22	0.11								
v/c Ratio		0.65	0.30	0.28	0.55					0.38		0.27
Uniform Delay, d1		31.4	5.0	14.5	16.2					29.7		28.5
Progression Factor		1.00	1.00	0.83	0.95					1.00		1.00
Incremental Delay, d2		1.2	0.2	0.2	0.2					0.5		0.3
Delay (s)		32.6	5.1	12.2	15.6					30.2		28.8
Level of Service		C	A	B	B					C		C
Approach Delay (s)		22.5			15.3			0.0			29.5	
Approach LOS		C			B			A			C	

Intersection Summary				
HCM 2000 Control Delay	20.5	HCM 2000 Level of Service	C	
HCM 2000 Volume to Capacity ratio	0.58			
Actuated Cycle Length (s)	117.0	Sum of lost time (s)	24.0	
Intersection Capacity Utilization	68.2%	ICU Level of Service	C	
Analysis Period (min)	15			

c   Critical Lane Group

F-4220

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	⬎	↑↑	↗	⬎	↑↑		⬎	↑↑	↗	⬎	↑↑	↗
Volume (veh/h)	149	213	262	175	109	57	449	1129	275	36	568	81
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1792	1792	1792	1776	1776	1900	1810	1810	1810	1810	1810	1810
Adj Flow Rate, veh/h	166	237	291	194	121	63	499	1254	306	40	631	90
Adj No. of Lanes	1	2	1	1	2	0	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	6	6	7	7	7	5	5	5	5	5	5
Cap, veh/h	281	626	627	318	719	354	538	1913	856	156	931	416
Arrive On Green	0.18	0.18	0.18	0.09	0.33	0.33	0.23	0.56	0.56	0.27	0.27	0.27
Sat Flow, veh/h	1150	3406	1524	1691	2193	1080	1723	3438	1538	320	3438	1538
Grp Volume(v), veh/h	166	237	291	194	91	93	499	1254	306	40	631	90
Grp Sat Flow(s),veh/h/ln	1150	1703	1524	1691	1687	1585	1723	1719	1538	320	1719	1538
Q Serve(g_s), s	14.3	6.3	14.4	9.0	4.0	4.3	20.4	26.5	11.4	10.8	17.0	4.7
Cycle Q Clear(g_c), s	14.3	6.3	14.4	9.0	4.0	4.3	20.4	26.5	11.4	10.8	17.0	4.7
Prop In Lane	1.00		1.00	1.00		0.68	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	281	626	627	318	553	520	538	1913	856	156	931	416
V/C Ratio(X)	0.59	0.38	0.46	0.61	0.17	0.18	0.93	0.66	0.36	0.26	0.68	0.22
Avail Cap(c_a), veh/h	335	787	699	318	633	595	692	2284	1022	162	993	444
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	40.5	37.2	22.2	30.5	24.8	24.9	20.5	16.1	12.8	31.6	33.8	29.3
Incr Delay (d2), s/veh	2.0	0.4	0.5	3.4	0.1	0.2	16.2	0.5	0.3	0.9	1.7	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.7	3.0	6.2	1.1	1.9	1.9	12.0	12.5	4.9	1.0	8.3	2.0
LnGrp Delay(d),s/veh	42.4	37.6	22.8	33.9	24.9	25.1	36.7	16.6	13.0	32.4	35.6	29.6
LnGrp LOS	D	D	C	C	C	C	D	B	B	C	D	C
Approach Vol, veh/h		694			378			2059			761	
Approach Delay, s/veh		32.5			29.6			20.9			34.7	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6	7	8
Phs Duration (G+Y+Rc), s	29.7	34.1		40.1		63.8	15.0	25.1
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0	6.0	6.0
Max Green Setting (Gmax), s	33.0	30.0		39.0		69.0	9.0	24.0
Max Q Clear Time (g_c+I1), s	22.4	19.0		6.3		28.5	11.0	16.4
Green Ext Time (p_c), s	1.3	9.1		4.6		24.3	0.0	2.7

Intersection Summary	
HCM 2010 Ctrl Delay	26.5
HCM 2010 LOS	C

F-4221

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↰	↑↑	↱	↰	↑↑		↰	↑↑	↱	↰	↑↑	↱
Volume (veh/h)	78	123	492	254	277	63	310	751	158	25	1047	102
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1810	1810	1810	1900	1827	1827	1827	1827	1827	1827
Adj Flow Rate, veh/h	87	137	547	282	308	70	344	834	176	28	1163	113
Adj No. of Lanes	1	2	1	1	2	0	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	5	5	5	4	4	4	4	4	4
Cap, veh/h	201	485	460	308	812	182	375	2095	937	277	1362	609
Arrive On Green	0.14	0.14	0.14	0.10	0.29	0.29	0.16	0.60	0.60	0.39	0.39	0.39
Sat Flow, veh/h	972	3438	1538	1723	2792	626	1740	3471	1553	545	3471	1553
Grp Volume(v), veh/h	87	137	547	282	188	190	344	834	176	28	1163	113
Grp Sat Flow(s),veh/h/ln	972	1719	1538	1723	1719	1699	1740	1736	1553	545	1736	1553
Q Serve(g_s), s	9.6	4.0	16.0	11.0	9.9	10.1	15.4	14.2	5.8	3.7	34.7	5.4
Cycle Q Clear(g_c), s	9.6	4.0	16.0	11.0	9.9	10.1	15.4	14.2	5.8	3.7	34.7	5.4
Prop In Lane	1.00		1.00	1.00		0.37	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	201	485	460	308	500	494	375	2095	937	277	1362	609
V/C Ratio(X)	0.43	0.28	1.19	0.92	0.38	0.38	0.92	0.40	0.19	0.10	0.85	0.19
Avail Cap(c_a), veh/h	201	485	460	308	500	494	453	2294	1026	284	1407	629
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	46.0	43.6	39.8	41.2	32.0	32.1	29.7	11.7	10.1	22.1	31.5	22.6
Incr Delay (d2), s/veh	1.5	0.3	104.9	30.7	0.5	0.5	21.1	0.1	0.1	0.2	5.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	1.9	27.8	6.2	4.8	4.8	12.7	6.8	2.5	0.6	17.6	2.3
LnGrp Delay(d),s/veh	47.5	43.9	144.6	71.9	32.5	32.6	50.8	11.9	10.2	22.2	36.7	22.7
LnGrp LOS	D	D	F	E	C	C	D	B	B	C	D	C
Approach Vol, veh/h		771			660			1354			1304	
Approach Delay, s/veh		115.8			49.4			21.5			35.2	
Approach LOS		F			D			C			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6	7	8
Phs Duration (G+Y+Rc), s	23.9	50.5		39.0		74.5	17.0	22.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0	6.0	6.0
Max Green Setting (Gmax), s	23.0	46.0		33.0		75.0	11.0	16.0
Max Q Clear Time (g_c+I1), s	17.4	36.7		12.1		16.2	13.0	18.0
Green Ext Time (p_c), s	0.5	7.8		5.8		28.9	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	48.2
HCM 2010 LOS	D

F-4222

Intersection

Int Delay, s/veh	0.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	19	18	221	25	29	278
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	200	-	-	250	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	10	10	8	8	3	3
Mvmt Flow	21	20	246	28	32	309

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	478	137	0	0	273	0
Stage 1	259	-	-	-	-	-
Stage 2	219	-	-	-	-	-
Critical Hdwy	7	7.1	-	-	4.16	-
Critical Hdwy Stg 1	6	-	-	-	-	-
Critical Hdwy Stg 2	6	-	-	-	-	-
Follow-up Hdwy	3.6	3.4	-	-	2.23	-
Pot Cap-1 Maneuver	497	862	-	-	1280	-
Stage 1	737	-	-	-	-	-
Stage 2	773	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	485	862	-	-	1280	-
Mov Cap-2 Maneuver	485	-	-	-	-	-
Stage 1	737	-	-	-	-	-
Stage 2	754	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	11.1		
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	485	862	1280	-
HCM Lane V/C Ratio	-	-	0.044	0.023	0.025	-
HCM Control Delay (s)	-	-	12.8	9.3	7.9	-
HCM Lane LOS	-	-	B	A	A	-
HCM 95th %tile Q(veh)	-	-	0	0	0	-

F-4223

Intersection

Int Delay, s/veh	0.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	18	19	264	29	25	250
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	200	-	-	250	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	9	9	6	6	3	3
Mvmt Flow	20	21	293	32	28	278

Major/Minor	Minor1			Major1		Major2	
Conflicting Flow All	503	163		0	0	326	0
Stage 1	309	-		-	-	-	-
Stage 2	194	-		-	-	-	-
Critical Hdwy	6.98	7.08		-	-	4.16	-
Critical Hdwy Stg 1	5.98	-		-	-	-	-
Critical Hdwy Stg 2	5.98	-		-	-	-	-
Follow-up Hdwy	3.59	3.39		-	-	2.23	-
Pot Cap-1 Maneuver	481	831		-	-	1223	-
Stage 1	697	-		-	-	-	-
Stage 2	799	-		-	-	-	-
Platoon blocked, %				-	-		-
Mov Cap-1 Maneuver	470	831		-	-	1223	-
Mov Cap-2 Maneuver	470	-		-	-	-	-
Stage 1	697	-		-	-	-	-
Stage 2	781	-		-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	11.2		
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	470	831	1223	-
HCM Lane V/C Ratio	-	-	0.043	0.025	0.023	-
HCM Control Delay (s)	-	-	13	9.4	8	-
HCM Lane LOS	-	-	B	A	A	-
HCM 95th %tile Q(veh)	-	-	0	0	0	-

F-4224

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	↰	↱	↑↑		↰	↑↑
Volume (veh/h)	145	131	115	311	209	88
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1638	1638	1792	1900	1759	1759
Adj Flow Rate, veh/h	161	146	128	346	232	98
Adj No. of Lanes	1	1	2	0	1	2
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	16	16	6	6	8	8
Cap, veh/h	242	216	1158	1036	632	2272
Arrive On Green	0.16	0.16	0.68	0.68	0.68	0.68
Sat Flow, veh/h	1560	1392	1792	1524	865	3431
Grp Volume(v), veh/h	161	146	128	346	232	98
Grp Sat Flow(s),veh/h/ln	1560	1392	1703	1524	865	1671
Q Serve(g_s), s	5.6	5.7	1.5	5.4	8.7	0.6
Cycle Q Clear(g_c), s	5.6	5.7	1.5	5.4	14.1	0.6
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	242	216	1158	1036	632	2272
V/C Ratio(X)	0.66	0.67	0.11	0.33	0.37	0.04
Avail Cap(c_a), veh/h	380	339	1158	1036	632	2272
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.99	0.99	1.00	1.00
Uniform Delay (d), s/veh	22.9	22.9	3.2	3.8	6.7	3.0
Incr Delay (d2), s/veh	3.1	3.6	0.2	0.9	1.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	2.4	0.7	2.5	2.3	0.3
LnGrp Delay(d),s/veh	26.0	26.5	3.4	4.7	8.4	3.1
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	307		474			330
Approach Delay, s/veh	26.2		4.3			6.8
Approach LOS	C		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		45.1				45.1		14.9
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		34.0				34.0		14.0
Max Q Clear Time (g_c+I1), s		7.4				16.1		7.7
Green Ext Time (p_c), s		5.5				4.9		0.5

Intersection Summary	
HCM 2010 Ctrl Delay	11.1
HCM 2010 LOS	B

F-4225

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	⬏	⬏	↑⬏		⬏	↑↑
Volume (veh/h)	314	211	82	147	133	135
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1681	1681	1810	1900	1792	1792
Adj Flow Rate, veh/h	349	234	91	163	148	150
Adj No. of Lanes	1	1	2	0	1	2
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	13	13	5	5	6	6
Cap, veh/h	434	387	1052	941	743	2085
Arrive On Green	0.27	0.27	0.61	0.61	0.61	0.61
Sat Flow, veh/h	1601	1429	1810	1538	1079	3495
Grp Volume(v), veh/h	349	234	91	163	148	150
Grp Sat Flow(s),veh/h/ln	1601	1429	1719	1538	1079	1703
Q Serve(g_s), s	11.0	7.8	1.2	2.5	3.8	1.0
Cycle Q Clear(g_c), s	11.0	7.8	1.2	2.5	6.3	1.0
Prop In Lane	1.00	1.00		1.00	1.00	
Lane Grp Cap(c), veh/h	434	387	1052	941	743	2085
V/C Ratio(X)	0.80	0.60	0.09	0.17	0.20	0.07
Avail Cap(c_a), veh/h	766	684	1052	941	743	2085
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	18.5	17.3	4.3	4.6	5.9	4.3
Incr Delay (d2), s/veh	3.5	1.5	0.2	0.4	0.6	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.3	3.2	0.6	1.1	1.2	0.5
LnGrp Delay(d),s/veh	22.0	18.8	4.5	5.0	6.5	4.3
LnGrp LOS	C	B	A	A	A	A
Approach Vol, veh/h	583		254			298
Approach Delay, s/veh	20.7		4.8			5.4
Approach LOS	C		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		39.3				39.3		20.7
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		22.0				22.0		26.0
Max Q Clear Time (g_c+I1), s		4.5				8.3		13.0
Green Ext Time (p_c), s		2.9				2.6		1.7

Intersection Summary	
HCM 2010 Ctrl Delay	13.1
HCM 2010 LOS	B

F-4226

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↱↱	↱	↱	↑↑	↑↱	
Volume (veh/h)	156	7	7	270	143	90
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1696	1696	1845	1845	1792	1900
Adj Flow Rate, veh/h	173	8	8	300	159	100
Adj No. of Lanes	2	1	1	2	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	12	12	3	3	6	6
Cap, veh/h	483	222	904	2535	1487	885
Arrive On Green	0.15	0.15	0.72	0.72	0.72	0.72
Sat Flow, veh/h	3134	1442	1105	3597	2145	1224
Grp Volume(v), veh/h	173	8	8	300	130	129
Grp Sat Flow(s),veh/h/ln	1567	1442	1105	1752	1703	1577
Q Serve(g_s), s	2.7	0.3	0.1	1.4	1.3	1.3
Cycle Q Clear(g_c), s	2.7	0.3	1.5	1.4	1.3	1.3
Prop In Lane	1.00	1.00	1.00			0.78
Lane Grp Cap(c), veh/h	483	222	904	2535	1232	1140
V/C Ratio(X)	0.36	0.04	0.01	0.12	0.11	0.11
Avail Cap(c_a), veh/h	1088	501	904	2535	1232	1140
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.94	0.94	1.00	1.00	0.94	0.94
Uniform Delay (d), s/veh	20.7	19.7	2.5	2.3	2.3	2.3
Incr Delay (d2), s/veh	0.4	0.1	0.0	0.1	0.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.2	0.1	0.0	0.7	0.6	0.6
LnGrp Delay(d),s/veh	21.1	19.8	2.5	2.4	2.4	2.5
LnGrp LOS	C	B	A	A	A	A
Approach Vol, veh/h	181			308	259	
Approach Delay, s/veh	21.1			2.4	2.4	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		45.6		14.4		45.6		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		29.0		19.0		29.0		
Max Q Clear Time (g_c+I1), s		3.5		4.7		3.3		
Green Ext Time (p_c), s		3.6		0.5		3.6		

Intersection Summary	
HCM 2010 Ctrl Delay	6.9
HCM 2010 LOS	A

F-4227

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations	↰↱	↱	↰	↑↑	↑↱	
Volume (veh/h)	83	11	7	146	284	165
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1727	1727	1863	1863	1810	1900
Adj Flow Rate, veh/h	92	12	8	162	316	183
Adj No. of Lanes	2	1	1	2	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	10	10	2	2	5	5
Cap, veh/h	415	191	794	2624	1570	889
Arrive On Green	0.13	0.13	0.74	0.74	1.00	1.00
Sat Flow, veh/h	3191	1468	895	3632	2209	1199
Grp Volume(v), veh/h	92	12	8	162	255	244
Grp Sat Flow(s),veh/h/ln	1596	1468	895	1770	1719	1598
Q Serve(g_s), s	1.4	0.4	0.1	0.7	0.0	0.0
Cycle Q Clear(g_c), s	1.4	0.4	0.1	0.7	0.0	0.0
Prop In Lane	1.00	1.00	1.00			0.75
Lane Grp Cap(c), veh/h	415	191	794	2624	1274	1185
V/C Ratio(X)	0.22	0.06	0.01	0.06	0.20	0.21
Avail Cap(c_a), veh/h	985	453	794	2624	1274	1185
HCM Platoon Ratio	1.00	1.00	1.00	1.00	2.00	2.00
Upstream Filter(I)	0.96	0.96	1.00	1.00	0.84	0.84
Uniform Delay (d), s/veh	21.5	21.0	1.9	1.9	0.0	0.0
Incr Delay (d2), s/veh	0.3	0.1	0.0	0.0	0.3	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.2	0.0	0.3	0.1	0.1
LnGrp Delay(d),s/veh	21.7	21.1	1.9	2.0	0.3	0.3
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	104			170	499	
Approach Delay, s/veh	21.6			2.0	0.3	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		46.8		13.2		46.8		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		31.0		17.0		31.0		
Max Q Clear Time (g_c+I1), s		2.7		3.4		2.0		
Green Ext Time (p_c), s		4.4		0.2		4.4		

Intersection Summary	
HCM 2010 Ctrl Delay	3.5
HCM 2010 LOS	A

F-4228

Intersection

Int Delay, s/veh	0.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	4	277	27	123
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	3	3
Mvmt Flow	0	0	4	308	30	137

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	193	30	30	0	-	0
Stage 1	30	-	-	-	-	-
Stage 2	163	-	-	-	-	-
Critical Hdwy	6.63	6.23	4.12	-	-	-
Critical Hdwy Stg 1	5.43	-	-	-	-	-
Critical Hdwy Stg 2	5.83	-	-	-	-	-
Follow-up Hdwy	3.519	3.319	2.218	-	-	-
Pot Cap-1 Maneuver	787	1044	1583	-	-	-
Stage 1	992	-	-	-	-	-
Stage 2	850	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	785	1044	1583	-	-	-
Mov Cap-2 Maneuver	785	-	-	-	-	-
Stage 1	992	-	-	-	-	-
Stage 2	847	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0	0.1	
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1583	-	-	-	-
HCM Lane V/C Ratio	0.003	-	-	-	-
HCM Control Delay (s)	7.3	0	0	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-

F-4229

Intersection							
Int Delay, s/veh	0.1						

Movement	EBL	EBR	NBL	NBT		SBT	SBR
Vol, veh/h	0	0	4	153		8	287
Conflicting Peds, #/hr	0	0	0	0		0	0
Sign Control	Stop	Stop	Free	Free		Free	Free
RT Channelized	-	None	-	None		-	None
Storage Length	0	-	-	-		-	0
Veh in Median Storage, #	0	-	-	0		0	-
Grade, %	0	-	-	0		0	-
Peak Hour Factor	90	90	90	90		90	90
Heavy Vehicles, %	2	2	4	4		2	2
Mvmt Flow	0	0	4	170		9	319

Major/Minor	Minor2			Major1		Major2	
Conflicting Flow All	103	9	9	0		-	0
Stage 1	9	-	-	-		-	-
Stage 2	94	-	-	-		-	-
Critical Hdwy	6.63	6.23	4.14	-		-	-
Critical Hdwy Stg 1	5.43	-	-	-		-	-
Critical Hdwy Stg 2	5.83	-	-	-		-	-
Follow-up Hdwy	3.519	3.319	2.236	-		-	-
Pot Cap-1 Maneuver	890	1072	1598	-		-	-
Stage 1	1014	-	-	-		-	-
Stage 2	920	-	-	-		-	-
Platoon blocked, %				-		-	-
Mov Cap-1 Maneuver	887	1072	1598	-		-	-
Mov Cap-2 Maneuver	887	-	-	-		-	-
Stage 1	1014	-	-	-		-	-
Stage 2	917	-	-	-		-	-

Approach	EB	NB	SB
HCM Control Delay, s	0	0.2	
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR	
Capacity (veh/h)	1598	-	-	-	-	
HCM Lane V/C Ratio	0.003	-	-	-	-	
HCM Control Delay (s)	7.3	0	0	-	-	
HCM Lane LOS	A	A	A	-	-	
HCM 95th %tile Q(veh)	0	-	-	-	-	

F-4230

Intersection									
Int Delay, s/veh	9.3								

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	267	4	4	4	0	6	0	8	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2
Mvmt Flow	297	4	4	4	0	7	0	9	4

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	48	47	26	50	45	11	26	0	0
Stage 1	34	34	-	11	11	-	-	-	-
Stage 2	14	13	-	39	34	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-
Pot Cap-1 Maneuver	953	845	1050	950	847	1070	1588	-	-
Stage 1	982	867	-	1010	886	-	-	-	-
Stage 2	1006	885	-	976	867	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	945	843	1050	940	845	1070	1588	-	-
Mov Cap-2 Maneuver	945	843	-	940	845	-	-	-	-
Stage 1	982	865	-	1010	886	-	-	-	-
Stage 2	1000	885	-	964	865	-	-	-	-

Approach	EB			WB			NB		
HCM Control Delay, s	10.6			8.6					
HCM LOS	B			A					

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1588	-	-	945	1014	1606	-	-
HCM Lane V/C Ratio	-	-	-	0.323	0.011	0.003	-	-
HCM Control Delay (s)	0	-	-	10.6	8.6	7.2	-	-
HCM Lane LOS	A	-	-	B	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	1	0	0	-	-

F-4231

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	4	23	0
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	0	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	2	2	2
Mvmt Flow	4	26	0

Major/Minor	Major2		
Conflicting Flow All	13	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.12	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.218	-	-
Pot Cap-1 Maneuver	1606	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1606	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt	

F-4232

Intersection

Int Delay, s/veh	8.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	140	4	4	4	0	6	0	11	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	4	4	4	2	2	2	2	2	2
Mvmt Flow	156	4	4	4	0	7	0	12	4

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	31	30	4	32	27	14	4	0	0
Stage 1	13	13	-	14	14	-	-	-	-
Stage 2	18	17	-	18	13	-	-	-	-
Critical Hdwy	7.14	6.54	6.24	7.12	6.52	6.22	4.12	-	-
Critical Hdwy Stg 1	6.14	5.54	-	6.12	5.52	-	-	-	-
Critical Hdwy Stg 2	6.14	5.54	-	6.12	5.52	-	-	-	-
Follow-up Hdwy	3.536	4.036	3.336	3.518	4.018	3.318	2.218	-	-
Pot Cap-1 Maneuver	972	859	1074	976	866	1066	1618	-	-
Stage 1	1002	881	-	1006	884	-	-	-	-
Stage 2	996	877	-	1001	885	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	964	857	1074	966	864	1066	1618	-	-
Mov Cap-2 Maneuver	964	857	-	966	864	-	-	-	-
Stage 1	1002	879	-	1006	884	-	-	-	-
Stage 2	990	877	-	989	883	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	9.5	8.6	
HCM LOS	A	A	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1618	-	-	963	1024	1587	-	-
HCM Lane V/C Ratio	-	-	-	0.171	0.011	0.003	-	-
HCM Control Delay (s)	0	-	-	9.5	8.6	7.3	-	-
HCM Lane LOS	A	-	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	1	0	0	-	-

F-4233

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	4	4	0
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	0	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	4	4	4
Mvmt Flow	4	4	0

Major/Minor	Major2		
Conflicting Flow All	17	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.14	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.236	-	-
Pot Cap-1 Maneuver	1587	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1587	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt		

F-4234

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7010 - Off to I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp	Freeway	Downstream Adj Ramp
☐ Yes　☐ On　 ☑ No　☐ Off L_{up} = 　　ft V_u = 　　veh/h	Freeway Number of Lanes, N　3 Ramp Number of Lanes, N　1 Acceleration Lane Length, L_A Deceleration Lane Length L_D　125 Freeway Volume, V_F　2886 Ramp Volume, V_R　854 Freeway Free-Flow Speed, S_{FF}　55.0 Ramp Free-Flow Speed, S_{FR}　45.0	☐ Yes　☐ On ☑ No　☐ Off L_{down} = 　　ft V_D = 　　veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2886	0.90	Level	10	0	0.952	1.00	3367
Ramp	854	0.90	Level	12	0	0.943	1.00	1006
UpStream								
DownStream								

Merge Areas	**Diverge Areas**
Estimation of v_{12}	**Estimation of v_{12}**
$V_{12} = V_F (P_{FM})$ L_{EQ} = 　(Equation 13-6 or 13-7) P_{FM} = 　using Equation (Exhibit 13-6) V_{12} = 　pc/h V_3 or V_{av34}　pc/h (Equation 13-14 or 13-17) Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No If Yes,V_{12a} = 　pc/h (Equation 13-16, 13-18, or 13-19)	$V_{12} = V_R + (V_F - V_R)P_{FD}$ L_{EQ} = 　(Equation 13-12 or 13-13) P_{FD} = 　0.630 using Equation (Exhibit 13-7) V_{12} = 　2492 pc/h V_3 or V_{av34}　875 pc/h (Equation 13-14 or 13-17) Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No If Yes,V_{12a} = 　pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	3367	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	2361	Exhibit 13-8	6750	No
V_R	1006	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | ### *Flow Entering Diverge Influence Area*

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	2492	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$ D_R = 　(pc/mi/ln) LOS = 　(Exhibit 13-2)	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$ D_R = 　24.6 (pc/mi/ln) LOS = 　C (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = 　(Exibit 13-11) S_R= 　mph (Exhibit 13-11) S_0= 　mph (Exhibit 13-11) S = 　mph (Exhibit 13-13)	D_s = 　0.389 (Exhibit 13-12) S_R= 　49.9 mph (Exhibit 13-12) S_0= 　60.3 mph (Exhibit 13-12) S = 　52.3 mph (Exhibit 13-13)

F-4235

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7010 - Off to I-26 EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On
☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	125
Freeway Volume, V_F	1972
Ramp Volume, V_R	461
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On
☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1972	0.90	Level	8	0	0.962	1.00	2279
Ramp	461	0.90	Level	19	0	0.913	1.00	561
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   0.677 using Equation (Exhibit 13-7)
V_{12} =   1724 pc/h
V_3 or V_{av34} 555 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	2279	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	1718	Exhibit 13-8	6750	No
V_R	561	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1724	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   18.0 (pc/mi/ln)
LOS =   B (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.348 (Exhibit 13-12)
S_R =   50.5 mph (Exhibit 13-12)
S_0 =   60.3 mph (Exhibit 13-12)
S =   52.6 mph (Exhibit 13-13)

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F-4236

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency/Company	Atkins	Weaving Segment Location	7020-I-26 EB On to I-26 WB Off
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	4		
Weaving segment length, L_S	450ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	45 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1173	0.90	9	0	1.5	1.2	0.957	1.00	1362
V_{RF}	293	0.90	9	0	1.5	1.2	0.957	1.00	340
V_{FR}	859	0.90	19	0	1.5	1.2	0.913	1.00	1045
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	1362							V =	2747
V_W	1385								
VR	0.504								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1385 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1473 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1473 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	12

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2747 pc/h	Weaving intensity factor, W	0.576
Weaving segment capacity, c_w	4555 veh/h	Weaving segment speed, S	32.9 mph
Weaving segment v/c ratio	0.577	Average weaving speed, S_W	34.0 mph
Weaving segment density, D	20.9 pc/mi/ln	Average non-weaving speed, S_{NW}	31.7 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	7875 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4237

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency/Company	Atkins	Weaving Segment Location	7020-I-26 EB On to I-26 WB Off
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	4		
Weaving segment length, L_S	450ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	45 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	726	0.90	7	0	1.5	1.2	0.966	1.00	835
V_{RF}	140	0.90	14	0	1.5	1.2	0.935	1.00	166
V_{FR}	785	0.90	18	0	1.5	1.2	0.917	1.00	951
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	835							V =	1952
V_W	1117								
VR	0.572								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1117 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1205 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1205 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	8

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1952 pc/h	Weaving intensity factor, W	0.492
Weaving segment capacity, c_w	4052 veh/h	Weaving segment speed, S	34.9 mph
Weaving segment v/c ratio	0.465	Average weaving speed, S_W	35.1 mph
Weaving segment density, D	14.0 pc/mi/ln	Average non-weaving speed, S_{NW}	34.6 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	8683 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4238

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7030 - NB On from I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A	200	
Deceleration Lane Length L_D		
Freeway Volume, V_F	1466	
Ramp Volume, V_R	387	
Freeway Free-Flow Speed, S_{FF}	55.0	
Ramp Free-Flow Speed, S_{FR}	45.0	

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1466	0.90	Level	9	0	0.957	1.00	1702
Ramp	387	0.90	Level	10	0	0.952	1.00	452
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.583   using Equation (Exhibit 13-6)

V_{12} =   992   pc/h

V_3 or V_{av34} 710   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h?   ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2   ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h?   ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2   ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	2154	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	1444	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   15.3 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.320 (Exibit 13-11)

S_R =   50.8 mph (Exhibit 13-11)

S_0 =   54.2 mph (Exhibit 13-11)

S =   51.9 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4239

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7030 - NB On from I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	3	☐ Yes ☐ On	
☑ No ☐ Off	Ramp Number of Lanes, N	1	☑ No ☐ Off	
	Acceleration Lane Length, L_A	200		
	Deceleration Lane Length L_D			
L_{up} = ft	Freeway Volume, V_F	866	L_{down} = ft	
	Ramp Volume, V_R	353		
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	55.0	V_D = veh/h	
	Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	866	0.90	Level	7	0	0.966	1.00	996
Ramp	353	0.90	Level	10	0	0.952	1.00	412
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =

P_{FM} =   0.583   using Equation (Exhibit 13-6)

V_{12} =   581   pc/h

V_3 or V_{av34} 415   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	1408	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	993	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$$

D_R =   11.8 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.314 (Exibit 13-11)

S_R =   50.9 mph (Exhibit 13-11)

S_0 =   55.0 mph (Exhibit 13-11)

S =   52.1 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4240

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove SB
Agency or Company	Atkins	Junction	7040 - Off to I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	225
Freeway Volume, V_F	1005
Ramp Volume, V_R	161
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1005	0.90	Level	5	0	0.976	1.00	1145
Ramp	161	0.90	Level	20	0	0.909	1.00	197
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =	(Equation 13-6 or 13-7)
P_{FM} =	using Equation (Exhibit 13-6)
V_{12} =	pc/h
V_3 or V_{av34}	pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =	(Equation 13-12 or 13-13)
P_{FD} =	1.000 using Equation (Exhibit 13-7)
V_{12} =	1145 pc/h
V_3 or V_{av34}	0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	1145	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	948	Exhibit 13-8	4500	No
V_R	197	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	1145	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) | Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =	(pc/mi/ln)
LOS =	(Exhibit 13-2)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =	12.1 (pc/mi/ln)
LOS =	B (Exhibit 13-2)

Speed Determination | Speed Determination

M_S =	(Exibit 13-11)
S_R =	mph (Exhibit 13-11)
S_0 =	mph (Exhibit 13-11)
S =	mph (Exhibit 13-13)

D_s =	0.316 (Exhibit 13-12)
S_R =	50.9 mph (Exhibit 13-12)
S_0 =	N/A mph (Exhibit 13-12)
S =	50.9 mph (Exhibit 13-13)

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F-4241

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	Cosgrove SB
Agency or Company	Atkins	Junction	7040 - Off to I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A		
Deceleration Lane Length L_D	225	
Freeway Volume, V_F	1793	
Ramp Volume, V_R	344	
Freeway Free-Flow Speed, S_{FF}	55.0	
Ramp Free-Flow Speed, S_{FR}	45.0	

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1793	0.90	Level	4	0	0.980	1.00	2032
Ramp	344	0.90	Level	8	0	0.962	1.00	398
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge Areas)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge Areas)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   2032 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

	Actual	Capacity		LOS F?
V_F	2032	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1634	Exhibit 13-8	4500	No
V_R	398	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable		Violation?
V_{12}	2032	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) | Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   19.7 (pc/mi/ln)

LOS =   B (Exhibit 13-2)

Speed Determination | Speed Determination

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

D_s =   0.334 (Exhibit 13-12)

S_R =   50.7 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   50.7 mph (Exhibit 13-13)

F-4242

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	Cosgrove SB
Agency/Company	Atkins	Weaving Segment Location	7050-I-26 WB On to I-26 EB Off
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	3		
Weaving segment length, L_S	475ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	45 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	439	0.90	9	0	1.5	1.2	0.957	1.00	510
V_{RF}	373	0.90	21	0	1.5	1.2	0.905	1.00	458
V_{FR}	405	0.90	9	0	1.5	1.2	0.957	1.00	470
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	510							V =	1438
V_W	928								
VR	0.645								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	928 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	982 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	982 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	5

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1438 pc/h	Weaving intensity factor, W	0.401
Weaving segment capacity, c_w	3559 veh/h	Weaving segment speed, S	36.3 mph
Weaving segment v/c ratio	0.387	Average weaving speed, S_W	36.4 mph
Weaving segment density, D	13.2 pc/mi/ln	Average non-weaving speed, S_{NW}	36.0 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	9574 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4243

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	Cosgrove SB
Agency/Company	Atkins	Weaving Segment Location	7050-I-26 WB On to I-26 EB Off
Date Performed	7/25/2014	Analysis Year	2018 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	3		
Weaving segment length, L_S	475ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	45 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1046	0.90	7	0	1.5	1.2	0.966	1.00	1203
V_{RF}	833	0.90	8	0	1.5	1.2	0.962	1.00	963
V_{FR}	403	0.90	7	0	1.5	1.2	0.966	1.00	463
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	1203							V =	2629
V_W	1426								
VR	0.542								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1426 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1480 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1480 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	11

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2629 pc/h	Weaving intensity factor, W	0.554
Weaving segment capacity, c_w	4275 veh/h	Weaving segment speed, S	32.5 mph
Weaving segment v/c ratio	0.594	Average weaving speed, S_W	34.3 mph
Weaving segment density, D	27.0 pc/mi/ln	Average non-weaving speed, S_{NW}	30.5 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	8326 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4244

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Cosgrove SB
Analysis Year	2018 Build-River Center Site	Junction	From I-26 EB
Analysis Time Period:	AM Peak	Segment ID	7060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	812	1,617	805
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	10%	10%	11%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.95	0.95
Demand Flow Rate, v_p (pc/h/ln)	474	629	944
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.23	0.30	0.45
Density, D_{MD} (pc/mi/ln)	8.3	11.0	16.5
LOS	A	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Cosgrove SB
Analysis Year	2018 Build-River Center Site	Junction	From I-26 EB
Analysis Time Period:	PM Peak	Segment ID	7060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	1,879	3,044	1,165
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	8%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.96	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,086	1,173	1,340
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.52	0.56	0.64
Density, D_{MD} (pc/mi/ln)	19.0	20.5	23.5
LOS	B	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	Montague NB
Agency or Company	Atkins	Junction	8010 - Off to I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp				Downstream Adj Ramp	
☐ Yes	☐ On	Freeway Number of Lanes, N	2	☐ Yes	☐ On
		Ramp Number of Lanes, N	1		
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
		Deceleration Lane Length L_D	350		
L_{up} = ft		Freeway Volume, V_F	1678	L_{down} = ft	
		Ramp Volume, V_R	537		
V_u = veh/h		Freeway Free-Flow Speed, S_{FF}	55.0	V_D = veh/h	
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1678	0.90	Level	9	0	0.957	1.00	1948
Ramp	537	0.90	Level	5	0	0.976	1.00	612
UpStream								
DownStream								

Merge Areas | Diverge Areas

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 1948 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	1948	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1336	Exhibit 13-8	4500	No
V_R	612	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	1948	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) | Level of Service Determination (if not F)

Level of Service Determination (if not F)	Level of Service Determination (if not F)
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 17.9 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = B (Exhibit 13-2)

Speed Determination | Speed Determination

Speed Determination	Speed Determination
M_S = (Exibit 13-11)	D_s = 0.353 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 50.4 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = N/A mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 50.4 mph (Exhibit 13-13)

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F-4247

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	Montague NB
Agency or Company	Atkins	Junction	8010 - Off to I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp	Freeway Number of Lanes, N	2	Downstream Adj Ramp

Upstream Adj Ramp
- ☐ Yes ☐ On
- ☑ No ☐ Off

L_{up} = ____ ft

V_u = ____ veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	350
Freeway Volume, V_F	1920
Ramp Volume, V_R	582
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
- ☐ Yes ☐ On
- ☑ No ☐ Off

L_{down} = ____ ft

V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1920	0.90	Level	7	0	0.966	1.00	2208
Ramp	582	0.90	Level	4	0	0.980	1.00	660
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = ____ (Equation 13-6 or 13-7)
P_{FM} = ____ using Equation (Exhibit 13-6)
V_{12} = ____ pc/h
V_3 or V_{av34} = ____ pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = ____ (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 2208 pc/h
V_3 or V_{av34} = 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	2208	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1548	Exhibit 13-8	4500	No
V_R	660	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2208	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = ____ (pc/mi/ln)
LOS = ____ (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = 20.1 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination (Merge)

M_S = ____ (Exibit 13-11)
S_R = ____ mph (Exhibit 13-11)
S_0 = ____ mph (Exhibit 13-11)
S = ____ mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S = 0.357 (Exhibit 13-12)
S_R = 50.4 mph (Exhibit 13-12)
S_0 = N/A mph (Exhibit 13-12)
S = 50.4 mph (Exhibit 13-13)

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)
ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Montague NB
Analysis Year	2018 Build-River Center Site	Junction	From I-26 EB
Analysis Time Period:	AM Peak	Segment ID	8020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,141	1,598	457
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	7%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.98
Demand Flow Rate, v_p (pc/h/ln)	662	613	520
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.32	0.29	0.27
Density, D_{MD} (pc/mi/ln)	11.6	10.7	9.1
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Montague NB
Analysis Year	2018 Build-River Center Site	Junction	From I-26 EB
Analysis Time Period:	PM Peak	Segment ID	8020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,338	1,584	246
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	5%	9%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.98	0.96
Demand Flow Rate, v_p (pc/h/ln)	769	601	286
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.37	0.29	0.15
Density, D_{MD} (pc/mi/ln)	13.5	10.5	5.0
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1) + P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Montague SB
Analysis Year	2018 Build-River Center Site	Junction	Off to I-26 EB
Analysis Time Period:	AM Peak	Segment ID	8030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,548	1,182	366
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	9%	9%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.96	0.96
Demand Flow Rate, v_p (pc/h/ln)	593	686	425
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.28	0.33	0.22
Density, D_{MD} (pc/mi/ln)	10.4	12.0	7.4
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,859	1,396	463
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	7%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.97	0.97
Demand Flow Rate, v_p (pc/h/ln)	706	803	530
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.34	0.38	0.28
Density, D_{MD} (pc/mi/ln)	12.4	14.1	9.3
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague SB
Agency or Company	Atkins	Junction	8040 - On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	550
Deceleration Lane Length L_D	
Freeway Volume, V_F	1182
Ramp Volume, V_R	415
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	1182	0.90	Level	9	0	0.957	1.00	1372
Ramp	415	0.90	Level	14	0	0.935	1.00	493
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} | Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   1.000   using Equation (Exhibit 13-6)
V_{12} =   1372   pc/h
V_3 or V_{av34} 0   pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   using Equation (Exhibit 13-7)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	1865	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1865	Exhibit 13-8	4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) | Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   16.3 (pc/mi/ln)
LOS =   B (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Speed Determination | Speed Determination

M_S =   0.297 (Exibit 13-11)
S_R =   51.1 mph (Exhibit 13-11)
S_0 =   N/A mph (Exhibit 13-11)
S =   51.1 mph (Exhibit 13-13)

D_s =   (Exhibit 13-12)
S_R =   mph (Exhibit 13-12)
S_0 =   mph (Exhibit 13-12)
S =   mph (Exhibit 13-13)

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F-4253

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information   *Site Information*

Analyst	AJR	Freeway/Dir of Travel	Montague SB
Agency or Company	Atkins	Junction	8040 - On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	550
Deceleration Lane Length L_D	
Freeway Volume, V_F	1396
Ramp Volume, V_R	249
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1396	0.90	Level	7	0	0.966	1.00	1605
Ramp	249	0.90	Level	8	0	0.962	1.00	288
UpStream								
DownStream								

Merge Areas	**Diverge Areas**
Estimation of v_{12}	**Estimation of v_{12}**

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 1605 pc/h	V_{12} = pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No	Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks   ### *Capacity Checks*

	Actual	Capacity	LOS F?
V_{FO}	1893	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area   ### *Flow Entering Diverge Influence Area*

	Actual	Max Desirable		Violation?
V_{R12}	1893	Exhibit 13-8	4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)   ### *Level of Service Determination (if not F)*

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = 16.7 (pc/mi/ln)	D_R = (pc/mi/ln)
LOS = B (Exhibit 13-2)	LOS = (Exhibit 13-2)

Speed Determination   ### *Speed Determination*

Merge	Diverge
M_S = 0.297 (Exibit 13-11)	D_s = (Exhibit 13-12)
S_R = 51.1 mph (Exhibit 13-11)	S_R = mph (Exhibit 13-12)
S_0 = N/A mph (Exhibit 13-11)	S_0 = mph (Exhibit 13-12)
S = 51.1 mph (Exhibit 13-13)	S = mph (Exhibit 13-13)

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F-4254

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)
ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR NB
Analysis Year	2018 Build-River Center Site	Junction	Merge from 26 EB & WB
Analysis Time Period:	AM Peak	Segment ID	9010
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	108	275	167
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	122	155	188
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.06	0.07	0.09
Density, D_{MD} (pc/mi/ln)	2.1	2.7	3.3
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR NB
Analysis Year	2018 Build-River Center Site	Junction	Merge from 26 EB & WB
Analysis Time Period:	PM Peak	Segment ID	9010
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	51	148	97
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	57	83	109
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.03	0.04	0.05
Density, D_{MD} (pc/mi/ln)	1.0	1.5	1.9
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	PAR NB
Agency or Company	Atkins	Junction	9020 - Off to Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build-River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	950
Freeway Volume, V_F	275
Ramp Volume, V_R	275
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	275	0.90	Level	3	0	0.985	1.00	310
Ramp	275	0.90	Level	3	0	0.985	1.00	310
UpStream								
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   1.000 using Equation (Exhibit 13-7)

V_{12} =   310 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	310	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	0	Exhibit 13-8	4500	No
V_R	310	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	310	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   -1.6 (pc/mi/ln)

LOS =   A (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   0.326 (Exhibit 13-12)

S_R =   50.8 mph (Exhibit 13-12)

S_0 =   N/A mph (Exhibit 13-12)

S =   50.8 mph (Exhibit 13-13)

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F-4257

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	PAR NB
Agency or Company	Atkins	Junction	9020 - Off to Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build-River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			
☐ Yes	☐ On		
☑ No	☐ Off		
L_{up} =	ft		
V_u =	veh/h		

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	950
Freeway Volume, V_F	148
Ramp Volume, V_R	148
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp			
☐ Yes	☐ On		
☑ No	☐ Off		
L_{down} =	ft		
V_D =	veh/h		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	148	0.90	Level	2	0	0.990	1.00	166
Ramp	148	0.90	Level	2	0	0.990	1.00	166
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F(P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 166 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity		LOS F?
V_F	166	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	0	Exhibit 13-8	4500	No
V_R	166	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	166	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = -2.9 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = A (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = (Exibit 13-11)	D_s = 0.313 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 50.9 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = N/A mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 50.9 mph (Exhibit 13-13)

F-4258

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information — Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	PAR SB
Agency or Company	Atkins	Junction	9030 - On from Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build-River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	0
Ramp Volume, V_R	127
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	0	0.90	Level	0	0	1.000	1.00	0
Ramp	127	0.90	Level	3	0	0.985	1.00	143
UpStream								
DownStream								

Merge Areas — Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   1.000 using Equation (Exhibit 13-6)

V_{12} =   0 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity		LOS F?
V_{FO}	143	Exhibit 13-8		No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	143	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   0.3 (pc/mi/ln)

LOS =   A (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.235 (Exibit 13-11)

S_R =   51.9 mph (Exhibit 13-11)

S_0 =   N/A mph (Exhibit 13-11)

S =   51.9 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4259

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	PAR SB
Agency or Company	Atkins	Junction	9030 - On from Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build-River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	2	☐ Yes ☐ On	
	Ramp Number of Lanes, N	1		
☑ No ☐ Off	Acceleration Lane Length, L_A	1000	☑ No ☐ Off	
	Deceleration Lane Length L_D			
L_{up} = _____ ft	Freeway Volume, V_F	0	L_{down} = _____ ft	
	Ramp Volume, V_R	291		
V_u = _____ veh/h	Freeway Free-Flow Speed, S_{FF}	55.0	V_D = _____ veh/h	
	Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	0	0.90	Level	0	0	1.000	1.00	0
Ramp	291	0.90	Level	2	0	0.990	1.00	327
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12}

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = _____ (Equation 13-6 or 13-7)	L_{EQ} = _____ (Equation 13-12 or 13-13)
P_{FM} = 1.000 using Equation (Exhibit 13-6)	P_{FD} = _____ using Equation (Exhibit 13-7)
V_{12} = 0 pc/h	V_{12} = _____ pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} _____ pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = _____ pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = _____ pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	327	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	327	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = 1.6 (pc/mi/ln)	D_R = _____ (pc/mi/ln)
LOS = A (Exhibit 13-2)	LOS = _____ (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = 0.236 (Exibit 13-11)	D_s = _____ (Exhibit 13-12)
S_R = 51.9 mph (Exhibit 13-11)	S_R = _____ mph (Exhibit 13-12)
S_0 = N/A mph (Exhibit 13-11)	S_0 = _____ mph (Exhibit 13-12)
S = 51.9 mph (Exhibit 13-13)	S = _____ mph (Exhibit 13-13)

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F-4260

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)
ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR SB
Analysis Year	2018 Build-River Center Site	Junction	Split to 26 EB & WB
Analysis Time Period:	AM Peak	Segment ID	9040
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	127	95	32
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	72	107	36
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.03	0.05	0.02
Density, D_{MD} (pc/mi/ln)	1.3	1.9	0.6
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF \cdot N \cdot f_{HV} \cdot f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175 \cdot v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR SB
Analysis Year	2018 Build-River Center Site	Junction	Split to 26 EB & WB
Analysis Time Period:	PM Peak	Segment ID	9040
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	291	203	88
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	163	228	99
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.07	0.10	0.05
Density, D_{MD} (pc/mi/ln)	2.9	4.0	1.7
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$
HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$
HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$
HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Arterial Level of Service: NB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Driveway	II	40	28.5	9.9	38.4	0.26	24.3	C
Carolina Ave	II	35	43.3	5.0	48.3	0.41	30.8	B
Reynolds Ave	II	35	44.7	9.2	53.9	0.43	28.7	B
ICTF Truck Dwy	II	40	30.5	17.7	48.2	0.30	22.4	C
McMillan Ave	II	40	15.4	12.1	27.5	0.13	17.5	D
Total	II		162.4	53.9	216.3	1.53	25.5	C

Arterial Level of Service: SB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Cosgrove Ave	II	40	15.4	26.4	41.8	0.13	11.5	F
Reynolds Ave	II	40	30.5	19.0	49.5	0.30	21.8	D
Carolina Ave	II	35	44.7	6.8	51.5	0.43	30.0	B
Burton Ln	II	40	39.6	13.2	52.8	0.41	28.1	B
Stromboli Ave	II	40	28.5	11.9	40.4	0.26	23.1	C
Total	II		158.7	77.3	236.0	1.53	23.4	C

F-4263

Arterial Level of Service: NB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Driveway	II	40	28.5	12.5	41.0	0.26	22.7	C
Carolina Ave	II	35	43.3	7.4	50.7	0.41	29.3	B
Reynolds Ave	II	35	44.7	17.3	62.0	0.43	24.9	C
ICTF Truck Dwy	II	40	30.5	28.1	58.6	0.30	18.4	D
McMillan Ave	II	40	15.4	16.7	32.1	0.13	15.0	E
Total	II		162.4	82.0	244.4	1.53	22.6	C

Arterial Level of Service: SB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Cosgrove Ave	II	40	15.4	18.7	34.1	0.13	14.1	E
Reynolds Ave	II	40	30.5	10.3	40.8	0.30	26.4	C
Carolina Ave	II	35	44.7	5.1	49.8	0.43	31.1	B
Burton Ln	II	40	39.6	10.1	49.7	0.41	29.9	B
Stromboli Ave	II	40	28.5	14.3	42.8	0.26	21.8	D
Total	II		158.7	58.5	217.2	1.53	25.4	C

Arterial Level of Service: NB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Burton Ln	III	34	35.4	6.6	42.0	0.29	25.3	B
Reynolds Ave	III	35	50.6	9.4	60.0	0.42	25.3	B
Cosgrove Ave	III	35	27.9	18.5	46.4	0.23	18.0	C
Dorchester Rd	III	35	18.7	3.4	22.1	0.15	23.8	C
McMillan Ave	III	35	24.5	14.5	39.0	0.20	18.8	C
Total	III		157.1	52.4	209.5	1.30	22.3	C

Arterial Level of Service: SB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Dorchester Rd	II	35	25.5	5.3	30.8	0.20	23.9	C
Cosgrove Ave	II	35	18.3	26.0	44.3	0.15	11.9	F
Reynolds Ave	II	35	27.6	3.3	30.9	0.23	27.1	C
Burton Ln	II	35	44.6	7.2	51.8	0.43	29.8	B
Stromboli Ave	II	37	32.4	2.3	34.7	0.29	30.6	B
Total	II		148.4	44.1	192.5	1.31	24.4	C

F-4265

Arterial Level of Service: NB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Burton Ln	III	34	35.4	9.8	45.2	0.29	23.5	C
Reynolds Ave	III	35	50.6	12.9	63.5	0.42	23.9	C
Cosgrove Ave	III	35	27.9	25.6	53.5	0.23	15.6	D
Dorchester Rd	III	35	18.7	3.2	21.9	0.15	24.0	B
McMillan Ave	III	35	24.5	20.4	44.9	0.20	16.4	D
Total	III		157.1	71.9	229.0	1.30	20.4	C

Arterial Level of Service: SB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Dorchester Rd	II	35	25.5	4.6	30.1	0.20	24.4	C
Cosgrove Ave	II	35	18.3	42.0	60.3	0.15	8.7	F
Reynolds Ave	II	35	27.6	6.4	34.0	0.23	24.6	C
Burton Ln	II	35	44.6	9.3	53.9	0.43	28.6	B
Stromboli Ave	II	37	32.4	2.0	34.4	0.29	30.8	B
Total	II		148.4	64.3	212.7	1.31	22.1	C

Appendix E

Traffic Analysis Worksheets

2038 Design Year

Build River Center Site Alternatives 5-7

Appendix E

Traffic Analysis Worksheets

2038 Design Year

Build River Center Site Alternatives 5-7

Interstate 26

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1010-EB Off to C-D
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	4	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A		
Deceleration Lane Length L_D	400	
Freeway Volume, V_F	9101	
Ramp Volume, V_R	1010	
Freeway Free-Flow Speed, S_{FF}	60.0	
Ramp Free-Flow Speed, S_{FR}	55.0	

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	9101	0.90	Level	16	0	0.926	1.00	10921
Ramp	1010	0.90	Level	5	0	0.976	1.00	1150
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   0.436 using Equation (Exhibit 13-7)

V_{12} =   5410 pc/h

V_3 or V_{av34} 2755 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   5521 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

	Actual	Capacity		LOS F?
V_F	10921	Exhibit 13-8	9200	Yes
$V_{FO} = V_F - V_R$	9771	Exhibit 13-8	9200	Yes
V_R	1150	Exhibit 13-10	2200	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	5410	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   48.1 (pc/mi/ln)

LOS =   F (Exhibit 13-2)

Speed Determination

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

D_s =   0.271 (Exhibit 13-12)

S_R =   55.1 mph (Exhibit 13-12)

S_0 =   59.2 mph (Exhibit 13-12)

S =   57.1 mph (Exhibit 13-13)

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F-4269

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1010-EB Off to C-D
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	4	☐ Yes ☐ On	
	Ramp Number of Lanes, N	1		
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off	
	Deceleration Lane Length L_D	400		
L_{up} = ft	Freeway Volume, V_F	5886	L_{down} = ft	
	Ramp Volume, V_R	540		
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D = veh/h	
	Ramp Free-Flow Speed, S_{FR}	55.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	5886	0.90	Level	12	0	0.943	1.00	6932
Ramp	540	0.90	Level	9	0	0.957	1.00	627
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Estimation of v_{12}	Estimation of v_{12}
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 0.436 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3376 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 1778 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks

	Actual	Capacity	LOS F?
V_F	6932	Exhibit 13-8	9200	No
$V_{FO} = V_F - V_R$	6305	Exhibit 13-8	9200	No
V_R	627	Exhibit 13-10	2200	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	3376	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F)

D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D

D_R =   29.7 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination

D_s =   0.224 (Exhibit 13-12)

S_R =   56.0 mph (Exhibit 13-12)

S_0 =   62.8 mph (Exhibit 13-12)

S =   59.3 mph (Exhibit 13-13)

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F-4270

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins	From/To	1015-Avai/Rem CD Off to CD On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	8091	veh/h	Peak-Hour Factor, PHF	0.90		
AADT		veh/day	%Trucks and Buses, P_T	16		
Peak-Hr Prop. of AADT, K			%RVs, P_R	0		
Peak-Hr Direction Prop, D			General Terrain:	Level		
DDHV = AADT x K x D		veh/h	Grade % Length	mi		
			Up/Down %			

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ 0.926	

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	4		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) 2427 pc/h/ln

S   47.6   mph

D = v_p / S   51.0   pc/mi/ln

LOS   F

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-4271

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR		
Agency or Company	Atkins		
Date Performed	7/25/2014		
Analysis Time Period	PM Peak		

Site Information

Highway/Direction of Travel	I-26 EB
From/To	1015-Avai/Rem CD Off to CD On
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	5346	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	13	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.939

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	4	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1582	pc/h/ln
S	60.0	mph
D = v_p / S	26.4	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4272

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 Build-River Center Site	Junction	EB Off to Aviation Ave
Analysis Time Period:	AM Peak	Segment ID	1020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,010	484	526
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	6%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.97	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,150	554	599
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.52	0.25	0.29
Density, D_{MD} (pc/mi/ln)	20.1	9.7	10.5
LOS	C	A	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 Build-River Center Site	Junction	EB Off to Aviation Ave
Analysis Time Period:	PM Peak	Segment ID	1020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	540	317	223
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	7%	11%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.95
Demand Flow Rate, v_p (pc/h/ln)	627	365	261
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.29	0.17	0.12
Density, D_{MD} (pc/mi/ln)	11.0	6.4	4.6
LOS	B	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

F-4274

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR	
Agency or Company	Atkins	
Date Performed	7/25/2014	
Analysis Time Period	AM Peak	

Project Description   *Navy Base ICTF*

Site Information

Highway/Direction of Travel	*I-26 EB C-D*
From/To	*1025 - Avia Off to Avia WB On*
Jurisdiction	
Analysis Year	*2038 Build - River Center Site*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*968*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*6*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ *554*   pc/h/ln

S	*55.0*	mph
D = v_p / S	*10.1*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   12:41 PM

F-4275

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 EB C-D
Agency or Company	Atkins	From/To	1025 - Avia Off to Avia WB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	634	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	7	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length mi		
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs / Calc Speed Adj and FFS

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures / Design (N)

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	365	pc/h/ln	Design LOS		
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	55.0	mph	S		mph
D = v_p / S	6.6	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	A		Required Number of Lanes, N		

Glossary / Factor Location

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service speed	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

F-4276

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 Build-River Center Site	Junction	WB Aviation EB On Loop
Analysis Time Period:	AM Peak	Segment ID	1030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	484	780	296
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	4%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	554	884	334
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.25	0.40	0.18
Density, D_{MD} (pc/mi/ln)	9.7	15.5	5.8
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

F-4277

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 Build-River Center Site	Junction	WB Aviation EB On Loop
Analysis Time Period:	PM Peak	Segment ID	1030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	317	788	471
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	4%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	365	893	529
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.17	0.41	0.28
Density, D_{MD} (pc/mi/ln)	6.4	15.6	9.3
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB - Aviation-Remount C-D
Weaving Segment Location	1040-EB Aviation to Remount
Analysis Year	2038 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	535ft
Freeway free-flow speed, FFS	55 mph

Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	296	0.90	3	0	1.5	1.2	0.985	1.00	334
V_{RF}	314	0.90	12	0	1.5	1.2	0.943	1.00	370
V_{FR}	484	0.90	6	0	1.5	1.2	0.971	1.00	554
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	334							V =	1258
V_W	924								
VR	0.734								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	924 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	962 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	962 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	14

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1258 pc/h	Weaving intensity factor, W	0.359
Weaving segment capacity, c_w	2902 veh/h	Weaving segment speed, S	44.7 mph
Weaving segment v/c ratio	0.427	Average weaving speed, S_W	44.4 mph
Weaving segment density, D	14.1 pc/mi/ln	Average non-weaving speed, S_{NW}	45.3 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	10694 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4279

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25//2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB - Aviation-Remount C-D
Weaving Segment Location	1040-EB Aviation to Remount
Analysis Year	2038 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	535ft
Freeway free-flow speed, FFS	55 mph

Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	471	0.90	2	0	1.5	1.2	0.990	1.00	529
V_{RF}	559	0.90	6	0	1.5	1.2	0.971	1.00	640
V_{FR}	317	0.90	7	0	1.5	1.2	0.966	1.00	365
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	529							V =	1534
V_W	1005								
VR	0.655								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1005 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1043 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	14 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1057 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	23

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1534 pc/h	Weaving intensity factor, W	0.387
Weaving segment capacity, c_w	3067 veh/h	Weaving segment speed, S	43.9 mph
Weaving segment v/c ratio	0.495	Average weaving speed, S_W	43.8 mph
Weaving segment density, D	17.5 pc/mi/ln	Average non-weaving speed, S_{NW}	44.1 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	9696 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

HCS 2010[TM] Version 6.41   Generated: 12/9/2014   12:44 PM

F-4280

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	Atkins	From/To	*1045-Remount Off to Remount On*
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	1220	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	7	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   701   pc/h/ln

S	55.0	mph
D = v_p / S	12.7	pc/mi/ln
LOS	B	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   12:45 PM

F-4281

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 EB C-D
Agency or Company	Atkins	From/To	1045-Remount Off to Remount On
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2060	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	4	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T-1) + P_R(E_R-1)]$	0.980

Speed Inputs

		Calc Speed Adj and FFS		
Lane Width	ft			
Rt-Side Lat. Clearance	ft	f_{LW}		mph
Number of Lanes, N	2	f_{LC}		mph
Total Ramp Density, TRD	ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0 mph	FFS	55.0	mph
Base free-flow Speed, BFFS	mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) = 1167 pc/h/ln

S = 55.0 mph

D = v_p / S = 21.2 pc/mi/ln

LOS = C

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4282

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 Build-River Center Site	Junction	Remount EB On Loop
Analysis Time Period:	AM Peak	Segment ID	1050
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	610	973	363
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	5%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	702	1,108	407
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.32	0.50	0.21
Density, D_{MD} (pc/mi/ln)	12.3	19.4	7.1
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

F-4283

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 Build-River Center Site	Junction	Remount EB On Loop
Analysis Time Period:	PM Peak	Segment ID	1050
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	1,030	1,448	418
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,167	1,633	469
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.53	0.74	0.25
Density, D_{MD} (pc/mi/ln)	20.4	28.6	8.2
LOS	C	D	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)} \qquad \text{HCM 2010, Equation 11-3}$$

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P} \qquad \text{HCM 2010, Equation 11-2}$$

$$D_{MD} = \frac{0.0175*v_f}{N} \qquad \text{HCM 2010, Equation 13-26}$$

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency/Company	Atkins	Weaving Segment Location	1060-Avi-Rem C-D to 526 C-D
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1850ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4557	0.90	14	0	1.5	1.2	0.935	1.00	5418
V_{RF}	548	0.90	14	0	1.5	1.2	0.935	1.00	652
V_{FR}	3534	0.90	30	0	1.5	1.2	0.870	1.00	4516
V_{RR}	425	0.90	30	0	1.5	1.2	0.870	1.00	543
V_{NW}	5961							V =	11129
V_W	5168								
VR	0.464								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	2 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	656

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	11129 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4830 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	2.153	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7413 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

F-4285

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency/Company	Atkins	Weaving Segment Location	1060-Avi-Rem C-D to 526 C-D
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1850ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2830	0.90	11	0	1.5	1.2	0.948	1.00	3317
V_{RF}	766	0.90	11	0	1.5	1.2	0.948	1.00	898
V_{FR}	2516	0.90	31	0	1.5	1.2	0.866	1.00	3229
V_{RR}	682	0.90	31	0	1.5	1.2	0.866	1.00	875
V_{NW}	4192							V =	8319
V_W	4127								
VR	0.496								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	2 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	407

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	8319 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4586 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.719	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7781 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4286

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1065 - I-526 CD Off to CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*5105*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*14*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.935*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	2023	pc/h/ln
S	*56.8*	mph
D = v_p / S	*35.6*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   12:51 PM

F-4287

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	AJR		Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins		From/To	1065 - I-526 CD Off to CD On
Date Performed	7/25/2014		Jurisdiction	
Analysis Time Period	PM Peak		Analysis Year	2038 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3596	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	11	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1405   pc/h/ln

S	60.0	mph
D = v_p / S	23.4	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   12:52 PM

F-4288

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 Build-River Center Site	Junction	EB Off to I-526 WB
Analysis Time Period:	AM Peak	Segment ID	1070
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,959	1,422	2,537
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	30%	53%	17%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.87	0.79	0.92
Demand Flow Rate, v_p (pc/h/ln)	2,529	1,999	3,058
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	1.15	0.91	1.46
Density, D_{MD} (pc/mi/ln)	44.3	35.0	53.5
LOS	F	D	F

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 Build-River Center Site	Junction	EB Off to I-526 WB
Analysis Time Period:	PM Peak	Segment ID	1070
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,198	1,163	2,035
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	31%	55%	18%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.87	0.78	0.92
Demand Flow Rate, v_p (pc/h/ln)	2,052	1,648	2,465
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.93	0.75	1.17
Density, D_{MD} (pc/mi/ln)	35.9	28.8	43.1
LOS	E	D	F

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1) + P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF \cdot N \cdot f_{HV} \cdot f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175 \cdot v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	I-26 EB C-D
From/To	1075-I526 WB Off to I526 WB On
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2844	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	0.90
%Trucks and Buses, P_T	53
%RVs, P_R	0
General Terrain:	Level
Grade % Length	mi
Up/Down %	

Calculate Flow Adjustments

f_p	1.00
E_T	1.5

E_R	1.2
$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.791

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1999	pc/h/ln
S	54.0	mph
D = v_p / S	37.0	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   12:53 PM

F-4291

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR		
Agency or Company	Atkins		
Date Performed	7/25/2014		
Analysis Time Period	PM Peak		

Site Information

Highway/Direction of Travel	I-26 EB C-D
From/To	1075-I526 WB Off to I526 WB On
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2326	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	55	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length mi		
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.784

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1648	pc/h/ln
S	55.0	mph
D = v_p / S	30.0	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes   S   - Speed
V - Hourly volume   D   - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   12:54 PM

F-4292

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB C-D
Weaving Segment Location	1080 - I-526 WB to I-526 EB
Analysis Year	2038 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	2		
Weaving segment length, L_S	620ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	55 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	556	0.90	8	0	1.5	1.2	0.962	1.00	642
V_{FR}	1422	0.90	53	0	1.5	1.2	0.791	1.00	1999
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	2641
V_W	2641								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2641 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.100	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4293

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB C-D
Agency/Company	Atkins	Weaving Segment Location	1080 - I-526 WB to I-526 EB
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	2		
Weaving segment length, L_S	620ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	55 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	490	0.90	8	0	1.5	1.2	0.962	1.00	566
V_{FR}	1163	0.90	55	0	1.5	1.2	0.784	1.00	1648
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	2214
V_W	2214								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2214 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2259 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2259 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2214 pc/h	Weaving intensity factor, W	0.627
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	39.6 mph
Weaving segment v/c ratio	0.923	Average weaving speed, S_W	39.6 mph
Weaving segment density, D	28.0 pc/mi/ln	Average non-weaving speed, S_{NW}	33.7 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4294

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1085-I526 EB Off to I526 EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*1112*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*8*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ *642* pc/h/ln

S	*55.0*	mph
$D = v_p / S$	*11.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S		mph
$D = v_p / S$		pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS   - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

HCS 2010[TM] Version 6.41   Generated: 12/9/2014   12:56 PM

F-4295

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1085-I526 EB Off to I526 EB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*980*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*8*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	566	pc/h/ln
S	*55.0*	mph
D = v_p / S	*10.3*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   12:56 PM

F-4296

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,411	2,112	299
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	10%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.95	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,400	1,232	337
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.64	0.56	0.15
Density, D_{MD} (pc/mi/ln)	24.5	21.6	5.9
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB
Analysis Year	2038 Build-River Center Site	Junction	I-526 EB Ramp Split
Analysis Time Period:	PM Peak	Segment ID	1088
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,786	2,442	344
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	7%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,602	1,404	388
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.73	0.64	0.18
Density, D_{MD} (pc/mi/ln)	28.0	24.6	6.8
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

F-4298

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 Build-River Center Site	Junction	I-526 EB On
Analysis Time Period:	AM Peak	Segment ID	1090
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	556	855	299
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	6%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	642	979	337
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.29	0.45	0.16
Density, D_{MD} (pc/mi/ln)	11.2	17.1	5.9
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 Build-River Center Site	Junction	I-526 EB On
Analysis Time Period:	PM Peak	Segment ID	1090
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	490	834	344
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	6%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	566	954	388
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.26	0.43	0.18
Density, D_{MD} (pc/mi/ln)	9.9	16.7	6.8
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency/Company	Atkins	Weaving Segment Location	1100 - I-526 CD to Montague SB
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1550ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4437	0.90	8	0	1.5	1.2	0.962	1.00	5127
V_{RF}	743	0.90	8	0	1.5	1.2	0.962	1.00	859
V_{FR}	668	0.90	15	0	1.5	1.2	0.930	1.00	798
V_{RR}	112	0.90	15	0	1.5	1.2	0.930	1.00	134
V_{NW}	5261							V =	6918
V_W	1657								
VR	0.240								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1657 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2010 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1153 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3163 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	652

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6918 pc/h	Weaving intensity factor, W	0.397
Weaving segment capacity, c_w	7846 veh/h	Weaving segment speed, S	41.3 mph
Weaving segment v/c ratio	0.848	Average weaving speed, S_W	47.2 mph
Weaving segment density, D	41.8 pc/mi/ln	Average non-weaving speed, S_{NW}	39.8 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	4944 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4301

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		**Site Information**	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency/Company	Atkins	Weaving Segment Location	1100 - I-526 CD to Montague SB
Date Performed	3/20/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1550ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2624	0.90	6	0	1.5	1.2	0.971	1.00	3003
V_{RF}	608	0.90	6	0	1.5	1.2	0.971	1.00	696
V_{FR}	972	0.90	8	0	1.5	1.2	0.962	1.00	1123
V_{RR}	226	0.90	8	0	1.5	1.2	0.962	1.00	261
V_{NW}	3264							V =	5083
V_W	1819								
VR	0.358								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1819 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2172 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	742 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2914 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	405

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5083 pc/h	Weaving intensity factor, W	0.372
Weaving segment capacity, c_w	6511 veh/h	Weaving segment speed, S	43.1 mph
Weaving segment v/c ratio	0.758	Average weaving speed, S_W	47.8 mph
Weaving segment density, D	29.5 pc/mi/ln	Average non-weaving speed, S_{NW}	40.8 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	6213 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4302

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins	From/To	1105-Mont SB Off to Mont SB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	5180	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	8	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1995	pc/h/ln	Design LOS		
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	57.2	mph	S		mph
D = v_p / S	34.9	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	D		Required Number of Lanes, N		

Glossary

		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service speed	BFFS - Base free-flow	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-4303

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Project Description   Navy Base ICTF

Site Information

Highway/Direction of Travel	I-26 EB
From/To	1105-Mont SB Off to Mont SB On
Jurisdiction	
Analysis Year	2038 Build - River Center Site

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3232	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.971

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1233	pc/h/ln
S	60.0	mph
D = v_p / S	20.5	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   1:09 PM

F-4304

Navy Base ICTF

FREEWAY WEAVING WORKSHEET								

General Information | **Site Information**

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency/Company	Atkins	Weaving Segment Location	1110 - Montague SB to Mont. NB
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	470ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4664	0.90	8	0	1.5	1.2	0.962	1.00	5390
V_{RF}	422	0.90	9	0	1.5	1.2	0.957	1.00	490
V_{FR}	516	0.90	6	0	1.5	1.2	0.971	1.00	591
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	5390							V =	6471
V_W	1081								
VR	0.167								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1081 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1223 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	595 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1818 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	253

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6471 pc/h	Weaving intensity factor, W	0.657
Weaving segment capacity, c_w	7746 veh/h	Weaving segment speed, S	44.1 mph
Weaving segment v/c ratio	0.803	Average weaving speed, S_W	42.2 mph
Weaving segment density, D	36.7 pc/mi/ln	Average non-weaving speed, S_{NW}	44.5 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	4202 ft

Notes
a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

HCS 2010[TM] Version 6.41   Generated: 12/9/2014 1:10 PM

F-4305

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1110 - Montague SB to Mont. NB
Analysis Year	2038 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	470ft
Freeway free-flow speed, FFS	60 mph

Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2946	0.90	6	0	1.5	1.2	0.971	1.00	3372
V_{RF}	535	0.90	6	0	1.5	1.2	0.971	1.00	612
V_{FR}	286	0.90	9	0	1.5	1.2	0.957	1.00	332
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3372							V =	4316
V_W	944								
VR	0.219								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	944 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1086 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	179 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1265 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	158

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4316 pc/h	Weaving intensity factor, W	0.494
Weaving segment capacity, c_w	7666 veh/h	Weaving segment speed, S	47.4 mph
Weaving segment v/c ratio	0.547	Average weaving speed, S_W	45.1 mph
Weaving segment density, D	22.8 pc/mi/ln	Average non-weaving speed, S_{NW}	48.0 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4728 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   1:10 PM

F-4306

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins	From/To	1115-Mont NB Off to Mont NB On
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	5086	veh/h	Peak-Hour Factor, PHF	0.90
AADT		veh/day	%Trucks and Buses, P_T	8
Peak-Hr Prop. of AADT, K			%RVs, P_R	0
Peak-Hr Direction Prop, D			General Terrain:	Level
DDHV = AADT x K x D		veh/h	Grade % Length	mi
			Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) 1959 pc/h/ln

S	57.7	mph
D = v_p / S	34.0	pc/mi/ln
LOS	D	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) pc/h/ln

S		mph
D = v_p / S		pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S   - Speed
V - Hourly volume   D   - Density
v_p - Flow rate   FFS - Free-flow speed
LOS   - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

HCS 2010™ Version 6.41   Generated: 12/9/2014   1:12 PM

F-4307

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins	From/To	1115-Mont NB Off to Mont NB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3481	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.971

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1328   pc/h/ln

S	60.0	mph
D = v_p / S	22.1	pc/mi/ln
LOS	C	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010™   Version 6.41   Generated: 12/9/2014   1:12 PM

F-4308

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1120 - EB On from Montague NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	850
Deceleration Lane Length L_D	
Freeway Volume, V_F	5086
Ramp Volume, V_R	719
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5086	0.90	Level	8	0	0.962	1.00	5877
Ramp	719	0.90	Level	8	0	0.962	1.00	831
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | Estimation of v_{12} (Diverge)

Merge:

$V_{12} = V_F (P_{FM})$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.601   using Equation (Exhibit 13-6)

V_{12} =   3534   pc/h

V_3 or V_{av34} 2343   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	6708	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	4365	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   33.8 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination — Merge

M_S =   0.551 (Exibit 13-11)

S_R =   50.1 mph (Exhibit 13-11)

S_0 =   53.2 mph (Exhibit 13-11)

S =   51.1 mph (Exhibit 13-13)

Speed Determination — Diverge

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

HCS2010™ Version 6.41

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F-4309

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1120 - EB On from Montague NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☒ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	850
Deceleration Lane Length L_D	
Freeway Volume, V_F	3481
Ramp Volume, V_R	779
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☒ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3481	0.90	Level	6	0	0.971	1.00	3984
Ramp	779	0.90	Level	7	0	0.966	1.00	896
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.601   using Equation (Exhibit 13-6)

V_{12} =   2396   pc/h

V_3 or V_{av34} 1588   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☒ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☒ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	4880	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	3292	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   25.4 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.349 (Exibit 13-11)

S_R =   53.7 mph (Exhibit 13-11)

S_0 =   56.1 mph (Exhibit 13-11)

S =   54.5 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

HCS2010™ Version 6.41   Generated: 12/9/2014   1:14 PM

F-4310

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR	Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins	From/To	1130 - Montague to Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Site Information

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	5805	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	7	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	2225	pc/h/ln
S	52.9	mph
D = v_p / S	42.1	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010™   Version 6.41   Generated: 12/9/2014   1:14 PM

F-4311

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1130 - Montague to Dorchester*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*4260*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*6*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1625	pc/h/ln
S	*60.0*	mph
D = v_p / S	*27.1*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   1:14 PM

F-4312

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1140-EB Off to Dorchester Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site
Project Description Navy Base ICTF			

Inputs

Upstream Adj Ramp	Freeway Number of Lanes, N	3		Downstream Adj Ramp
☐ Yes ☐ On	Ramp Number of Lanes, N	1		☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A			☑ No ☐ Off
	Deceleration Lane Length L_D	380		
L_{up} = ft	Freeway Volume, V_F	5805		L_{down} = ft
	Ramp Volume, V_R	565		
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	60.0		V_D = veh/h
	Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5805	0.90	Level	7	0	0.966	1.00	6676
Ramp	565	0.90	Level	12	0	0.943	1.00	665
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 0.563 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 4046 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 2630 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	6676	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	6011	Exhibit 13-8	6900	No
V_R	665	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	4046	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge: $D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Diverge: $D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   35.6 (pc/mi/ln)

LOS =   E (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = (Exibit 13-11)	D_s = 0.358 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 53.6 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = 59.5 mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 55.7 mph (Exhibit 13-13)

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F-4313

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1140-EB Off to Dorchester Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes　☐ On

☑ No　☐ Off

L_{up} = 　　ft

V_u = 　　veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	380
Freeway Volume, V_F	4260
Ramp Volume, V_R	392
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes　☐ On

☑ No　☐ Off

L_{down} = 　　ft

V_D = 　　veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4260	0.90	Level	6	0	0.971	1.00	4875
Ramp	392	0.90	Level	15	0	0.930	1.00	468
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = 　　(Equation 13-6 or 13-7)

P_{FM} = 　　using Equation (Exhibit 13-6)

V_{12} = 　　pc/h

V_3 or V_{av34} 　　pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = 　　pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = 　　(Equation 13-12 or 13-13)

P_{FD} = 　0.617　using Equation (Exhibit 13-7)

V_{12} = 　3185　pc/h

V_3 or V_{av34} 　1690　pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = 　　pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge:

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Diverge:

	Actual	Capacity	LOS F?
V_F	4875	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4407	Exhibit 13-8	6900	No
V_R	468	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Merge:

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Diverge:

	Actual	Max Desirable	Violation?
V_{12}	3185	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge:

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 　　(pc/mi/ln)

LOS = 　　(Exhibit 13-2)

Diverge:

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = 　28.2　(pc/mi/ln)

LOS = 　D (Exhibit 13-2)

Speed Determination

Merge:

M_S = 　　(Exibit 13-11)

S_R = 　　mph (Exhibit 13-11)

S_0 = 　　mph (Exhibit 13-11)

S = 　　mph (Exhibit 13-13)

Diverge:

D_S = 　0.340 (Exhibit 13-12)

S_R = 　53.9 mph (Exhibit 13-12)

S_0 = 　63.1 mph (Exhibit 13-12)

S = 　56.8 mph (Exhibit 13-13)

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F-4314

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1145-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*5240*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*7*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ *2009*   pc/h/ln

S	*57.0*	mph
$D = v_p / S$	*35.3*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S		mph
$D = v_p / S$		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4315

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins	From/To	1145-Dorches Off to Dorches On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3868	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.971

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1476   pc/h/ln

S	60.0	mph
D = v_p / S	24.6	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4316

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Junction	1150 - EB On from Dorchester
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☒ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	560
Deceleration Lane Length L_D	
Freeway Volume, V_F	5240
Ramp Volume, V_R	719
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☒ Yes   ☐ On

☐ No   ☒ Off

L_{down} =   2100 ft

V_D =   872 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5240	0.90	Level	7	0	0.966	1.00	6026
Ramp	719	0.90	Level	11	0	0.948	1.00	843
UpStream								
DownStream	872	0.90	Level	12	0	0.943	1.00	1027

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   6058.28   (Equation 13-6 or 13-7)

P_{FM} =   0.677   using Equation (Exhibit 13-6)

V_{12} =   4081   pc/h

V_3 or V_{av34} 1945   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☒ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☒ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	6869	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	4924	Exhibit 13-8 4600:All	Yes

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   40.0 (pc/mi/ln)

LOS =   E (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.807 (Exibit 13-11)

S_R =   45.5 mph (Exhibit 13-11)

S_0 =   54.8 mph (Exhibit 13-11)

S =   47.8 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4317

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1150 - EB On from Dorchester
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ___ ft

V_u = ___ veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	560
Deceleration Lane Length L_D	
Freeway Volume, V_F	3868
Ramp Volume, V_R	554
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 2100 ft

V_D = 1253 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3868	0.90	Level	6	0	0.971	1.00	4427
Ramp	554	0.90	Level	13	0	0.939	1.00	656
UpStream								
DownStream	1253	0.90	Level	7	0	0.966	1.00	1441

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Estimation of v_{12} (Merge)	**Estimation of v_{12}** (Diverge)
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = 8500.47 (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 0.729 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 3227 pc/h	V_{12} = pc/h
V_3 or V_{av34} 1200 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	5083	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	3883	Exhibit 13-8 4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = 31.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = 0.460 (Exibit 13-11)

S_R = 51.7 mph (Exhibit 13-11)

S_0 = 57.5 mph (Exhibit 13-11)

S = 53.0 mph (Exhibit 13-13)

Speed Determination

D_s = (Exhibit 13-12)

S_R = mph (Exhibit 13-12)

S_0 = mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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F-4318

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information   Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1160-EB Off to Cosgrove SB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes   ☑ On

☐ No   ☐ Off

L_{up} =   2100 ft

V_u =   719 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	5959
Ramp Volume, V_R	872
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5959	0.90	Level	7	0	0.966	1.00	6853
Ramp	872	0.90	Level	12	0	0.943	1.00	1027
UpStream	719	0.90	Level	11	0	0.948	1.00	843
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F \left(P_{FM} \right)$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   5598.84 (Equation 13-12 or 13-13)

P_{FD} =   0.541 using Equation (Exhibit 13-7)

V_{12} =   4181 pc/h

V_3 or V_{av34} 2672 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	6853	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5826	Exhibit 13-8	6900	No
V_R	1027	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4181	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$$

D_R =   38.4 (pc/mi/ln)

LOS =   E (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   0.390 (Exhibit 13-12)

S_R =   53.0 mph (Exhibit 13-12)

S_0 =   59.3 mph (Exhibit 13-12)

S =   55.3 mph (Exhibit 13-13)

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F-4319

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1160-EB Off to Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes   ☑ On

☐ No   ☐ Off

L_{up} =   2100 ft

V_u =   554 veh/h

Freeway Number of Lanes, N	3	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A		
Deceleration Lane Length L_D	200	
Freeway Volume, V_F	4422	
Ramp Volume, V_R	1253	
Freeway Free-Flow Speed, S_{FF}	60.0	
Ramp Free-Flow Speed, S_{FR}	45.0	

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4422	0.90	Level	6	0	0.971	1.00	5061
Ramp	1253	0.90	Level	7	0	0.966	1.00	1441
UpStream	554	0.90	Level	13	0	0.939	1.00	656
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   8422.46 (Equation 13-12 or 13-13)

P_{FD} =   0.567 using Equation (Exhibit 13-7)

V_{12} =   3494 pc/h

V_3 or V_{av34} 1567 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	5061	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3620	Exhibit 13-8	6900	No
V_R	1441	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3494	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 \, v_R + 0.0078 \, V_{12} - 0.00627 \, L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 \, V_{12} - 0.009 \, L_D$$

D_R =   32.5 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   0.428 (Exhibit 13-12)

S_R =   52.3 mph (Exhibit 13-12)

S_0 =   63.6 mph (Exhibit 13-12)

S =   55.3 mph (Exhibit 13-13)

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F-4320

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR	
Agency or Company	Atkins	
Date Performed	7/25/2014	
Analysis Time Period	AM Peak	

Site Information

Highway/Direction of Travel	I-26 EB
From/To	1165-Cosg SB Off to Cosg SB On
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	5087	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	8	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R		1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962	

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

v_p	1959	pc/h/ln
S	57.7	mph
D = v_p / S	34.0	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

v_p		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4321

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins	From/To	1165-Cosg SB Off to Cosg SB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3169	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	7	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ 1215   pc/h/ln

S	60.0	mph
D = v_p / S	20.3	pc/mi/ln
LOS	C	

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   1:28 PM

F-4322

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency/Company	Atkins	Weaving Segment Location	1170 - Cosgrove SB to Cos. NB
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	600ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4779	0.90	8	0	1.5	1.2	0.962	1.00	5522
V_{RF}	436	0.90	2	0	1.5	1.2	0.990	1.00	489
V_{FR}	308	0.90	7	0	1.5	1.2	0.966	1.00	354
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	5522							V =	6365
V_W	843								
VR	0.132								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	843 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1031 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	692 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1723 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	331

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6365 pc/h	Weaving intensity factor, W	0.519
Weaving segment capacity, c_w	7888 veh/h	Weaving segment speed, S	46.1 mph
Weaving segment v/c ratio	0.776	Average weaving speed, S_W	44.6 mph
Weaving segment density, D	34.5 pc/mi/ln	Average non-weaving speed, S_{NW}	46.3 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	3857 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4323

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency/Company	Atkins	Weaving Segment Location	1170 - Cosgrove SB to Cos. NB
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	600ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3011	0.90	7	0	1.5	1.2	0.966	1.00	3463
V_{RF}	440	0.90	2	0	1.5	1.2	0.990	1.00	494
V_{FR}	158	0.90	13	0	1.5	1.2	0.939	1.00	187
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3463							V =	4144
V_W	681								
VR	0.164								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	681 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	869 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	268 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1137 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	208

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4144 pc/h	Weaving intensity factor, W	0.374
Weaving segment capacity, c_w	7834 veh/h	Weaving segment speed, S	49.7 mph
Weaving segment v/c ratio	0.511	Average weaving speed, S_W	47.7 mph
Weaving segment density, D	20.8 pc/mi/ln	Average non-weaving speed, S_{NW}	50.1 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4175 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4324

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins	From/To	1175-Cosg NB Off to Cosg NB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	5215	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	8	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   2009   pc/h/ln

S	57.0	mph
D = v_p / S	35.3	pc/mi/ln
LOS	E	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-4325

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR	Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins	From/To	1175-Cosg NB Off to Cosg NB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Site Information

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3451	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	7	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R		1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$		0.966

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1323	pc/h/ln
S	60.0	mph
D = v_p / S	22.0	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010™   Version 6.41   Generated: 12/9/2014   1:30 PM

F-4326

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Project Description   Navy Base ICTF

Site Information

Freeway/Dir of Travel	I-26 EB
Junction	1180 - EB On from Cosgrove NB
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☒ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	440
Deceleration Lane Length L_D	
Freeway Volume, V_F	5215
Ramp Volume, V_R	881
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☒ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5215	0.90	Level	8	0	0.962	1.00	6026
Ramp	881	0.90	Level	17	0	0.922	1.00	1062
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.590   using Equation (Exhibit 13-6)

V_{12} =   3554   pc/h

V_3 or V_{av34} 2472   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☒ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☒ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	7088	Exhibit 13-8	Yes

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	4616	Exhibit 13-8 4600:All	Yes

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   38.2 (pc/mi/ln)

LOS =   F (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.676 (Exibit 13-11)

S_R =   47.8 mph (Exhibit 13-11)

S_0 =   52.4 mph (Exhibit 13-11)

S =   49.3 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4327

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1180 - EB On from Cosgrove NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☒ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	440
Deceleration Lane Length L_D	
Freeway Volume, V_F	3451
Ramp Volume, V_R	478
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☒ No ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3451	0.90	Level	7	0	0.966	1.00	3969
Ramp	478	0.90	Level	27	0	0.881	1.00	603
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.590   using Equation (Exhibit 13-6)

V_{12} =   2341   pc/h

V_3 or V_{av34} 1628   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☒ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☒ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	4572	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	2944	Exhibit 13-8 4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) | Level of Service Determination (if not F)

Merge:

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   25.4 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Diverge:

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination | Speed Determination

Merge:

M_S =   0.355 (Exibit 13-11)

S_R =   53.6 mph (Exhibit 13-11)

S_0 =   55.9 mph (Exhibit 13-11)

S =   54.4 mph (Exhibit 13-13)

Diverge:

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4328

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1190 - Cosgrove to US-52*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*6096*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*8*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   *2348*   pc/h/ln

S	*49.8*	mph
D = v_p / S	*47.1*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM] Version 6.41   Generated: 12/9/2014   1:32 PM

F-4329

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*
Agency or Company	*Atkins*
Date Performed	*7/25/2014*
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-26 EB*
From/To	*1190 - Cosgrove to US-52*
Jurisdiction	
Analysis Year	*2038 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*3929*	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	*0.90*	
%Trucks and Buses, P_T	*7*	
%RVs, P_R	*0*	
General Terrain:	*Level*	
Grade % Length	*mi*	
Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	
E_T	*1.5*	

E_R	*1.2*
f_{HV} = $1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1506*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4330

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1200-EB Off to US-52 & PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On
☒ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	340
Freeway Volume, V_F	6096
Ramp Volume, V_R	813
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On
☒ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	6096	0.90	Level	8	0	0.962	1.00	7044
Ramp	813	0.90	Level	25	0	0.889	1.00	1016
UpStream								
DownStream								

Merge Areas / Diverge Areas

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**

Merge — Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation   (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge — Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   0.537 using Equation (Exhibit 13-7)
V_{12} =   4254 pc/h
V_3 or V_{av34} 2790 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☒ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☒ No
If Yes, V_{12a} =   4344 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Diverge

	Actual	Capacity		LOS F?
V_F	7044	Exhibit 13-8	6900	Yes
$V_{FO} = V_F - V_R$	6028	Exhibit 13-8	6900	No
V_R	1016	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4254	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   38.6 (pc/mi/ln)
LOS =   F (Exhibit 13-2)

Speed Determination

Merge

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

Diverge

D_s =   0.389 (Exhibit 13-12)
S_R =   53.0 mph (Exhibit 13-12)
S_0 =   59.2 mph (Exhibit 13-12)
S =   55.2 mph (Exhibit 13-13)

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F-4331

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1200-EB Off to US-52
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3		Downstream Adj Ramp	
☐Yes ☐On		Ramp Number of Lanes, N	1		☐Yes ☐On	
		Acceleration Lane Length, L_A				
☑No ☐Off		Deceleration Lane Length L_D	340		☑No ☐Off	
		Freeway Volume, V_F	3929			
L_{up} = ft		Ramp Volume, V_R	670		L_{down} = ft	
		Freeway Free-Flow Speed, S_{FF}	60.0			
V_u = veh/h		Ramp Free-Flow Speed, S_{FR}	45.0		V_D = veh/h	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3929	0.90	Level	7	0	0.966	1.00	4518
Ramp	670	0.90	Level	16	0	0.926	1.00	804
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Estimation of v_{12}	Estimation of v_{12}
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 0.610 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3070 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 1448 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No	Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?		Actual	Capacity	LOS F?
				V_F	4518	Exhibit 13-8 6900	No
V_{FO}		Exhibit 13-8		$V_{FO} = V_F - V_R$	3714	Exhibit 13-8 6900	No
				V_R	804	Exhibit 13-10 2100	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?		Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8		V_{12}	3070	Exhibit 13-8 4400:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 27.6 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = C (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = (Exibit 13-11)	D_s = 0.370 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 53.3 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = 64.1 mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 56.4 mph (Exhibit 13-13)

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F-4332

BASIC FREEWAY SEGMENTS WORKSHEET

General Information			*Site Information*	
Analyst	*AJR*		Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*		From/To	*1205 - PAR Off to PAR On*
Date Performed	*7/25/2014*		Jurisdiction	
Analysis Time Period	*AM Peak*		Analysis Year	*2038 Build - River Center Site*

Project Description	*Navy Base ICTF*

☑ Oper.(LOS)	☐ Des.(N)	☐ Planning Data

Flow Inputs

Volume, V	5283	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	f_{HV} = $1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs / Calc Speed Adj and FFS

Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures / Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

v_p	2035	pc/h/ln
S	56.6	mph
D = v_p / S	36.0	pc/mi/ln
LOS	E	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

v_p		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary / Factor Location

N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service speed	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-4333

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR		
Agency or Company	Atkins		
Date Performed	7/25/2014		
Analysis Time Period	PM Peak		

Site Information

Highway/Direction of Travel	I-26 EB
From/To	1205 - PAR Off to PAR On
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3259	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	7	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1249	pc/h/ln
S	60.0	mph
D = v_p / S	20.8	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4334

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	EB US-52 & PAR Off Ramp
Analysis Year	2038 Build-River Center Site	Junction	US-52 & PAR EB Ramp Split
Analysis Time Period:	AM Peak	Segment ID	1208
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	45	55	45
Volume, V (veh/h)	813	500	313
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	25%	15%	41%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.89	0.93	0.83
Demand Flow Rate, v_p (pc/h/ln)	1,016	597	419
Capacity Flow Rate, c (pc/h/ln)	2,100	2,200	2,100
v/c ratio	0.48	0.27	0.20
Density, D_{MD} (pc/mi/ln)	17.8	10.4	7.3
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	EB US-52 & PAR Off Ramp
Analysis Year	2038 Build-River Center Site	Junction	US-52 & PAR EB Ramp Split
Analysis Time Period:	PM Peak	Segment ID	1208
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	45	55	45
Volume, V (veh/h)	670	562	108
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	16%	12%	36%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.93	0.94	0.85
Demand Flow Rate, v_p (pc/h/ln)	804	662	142
Capacity Flow Rate, c (pc/h/ln)	2,100	2,200	2,100
v/c ratio	0.38	0.30	0.07
Density, D_{MD} (pc/mi/ln)	14.1	11.6	2.5
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Project Description   Navy Base ICTF

Site Information

Freeway/Dir of Travel	I-26 EB
Junction	1210 - EB On from PAR
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☒ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	1000
Deceleration Lane Length L_D	
Freeway Volume, V_F	5283
Ramp Volume, V_R	328
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp

☐ Yes   ☐ On

☒ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5283	0.90	Level	8	0	0.962	1.00	6105
Ramp	328	0.90	Level	41	0	0.830	1.00	439
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.605   using Equation (Exhibit 13-6)

V_{12} =   3697   pc/h

V_3 or V_{av34} 2408   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☒ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2   ☐ Yes ☒ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2   ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	6544	Exhibit 13-8	No

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	4136	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   31.3 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination

M_S =   0.455 (Exibit 13-11)

S_R =   51.8 mph (Exhibit 13-11)

S_0 =   52.8 mph (Exhibit 13-11)

S =   52.2 mph (Exhibit 13-13)

Speed Determination

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4337

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information	Site Information
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1210 - EB On from PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A	1000	
Deceleration Lane Length L_D		
Freeway Volume, V_F	3259	
Ramp Volume, V_R	625	
Freeway Free-Flow Speed, S_{FF}	60.0	
Ramp Free-Flow Speed, S_{FR}	55.0	

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3259	0.90	Level	7	0	0.966	1.00	3748
Ramp	625	0.90	Level	36	0	0.847	1.00	819
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | ### Estimation of v_{12} (Diverge)

Merge Areas — Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =

P_{FM} =   0.605   using Equation (Exhibit 13-6)

V_{12} =   2269 pc/h

V_3 or V_{av34} 1479 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas — Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	4567	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	3088	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   22.9 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.297 (Exibit 13-11)

S_R =   54.7 mph (Exhibit 13-11)

S_0 =   56.5 mph (Exhibit 13-11)

S =   55.2 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4338

BASIC FREEWAY SEGMENTS WORKSHEET

General Information			*Site Information*	
Analyst	*AJR*		Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*		From/To	*1220 - PAR to Heriot*
Date Performed	*4/25/2014*		Jurisdiction	
Analysis Time Period	*AM Peak*		Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*5611*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

			### Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$

	2140	pc/h/ln
S	*54.7*	mph
D = v_p / S	*39.1*	pc/mi/ln
LOS	*E*	

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   1:39 PM

F-4339

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	4/25/2014
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	I-26 EB
From/To	1220 - PAR to Heriot
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3884	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	5	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R		1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$		0.976

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1474	pc/h/ln
S	60.0	mph
D = v_p / S	24.6	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4340

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1230-EB Off to Heriot St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A		
Deceleration Lane Length L_D	200	
Freeway Volume, V_F	5611	
Ramp Volume, V_R	726	
Freeway Free-Flow Speed, S_{FF}	55.0	
Ramp Free-Flow Speed, S_{FR}	45.0	

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} =   1400 ft

V_D =   817 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5611	0.90	Level	6	0	0.971	1.00	6421
Ramp	726	0.90	Level	5	0	0.976	1.00	827
UpStream								
DownStream	817	0.90	Level	10	0	0.952	1.00	953

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   1492.19 (Equation 13-12 or 13-13)

P_{FD} =   0.566 using Equation (Exhibit 13-7)

V_{12} =   3991 pc/h

V_3 or V_{av34} 2430 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

	Actual	Capacity		LOS F?
V_F	6421	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	5594	Exhibit 13-8	6750	No
V_R	827	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable		Violation?
V_{12}	3991	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   36.8 (pc/mi/ln)

LOS =   E (Exhibit 13-2)

Speed Determination

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

D_s =   0.372 (Exhibit 13-12)

S_R =   50.2 mph (Exhibit 13-12)

S_0 =   54.8 mph (Exhibit 13-12)

S =   51.8 mph (Exhibit 13-13)

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F-4341

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information   Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1230-EB Off to Heriot St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3	
Ramp Number of Lanes, N	1	
Acceleration Lane Length, L_A		
Deceleration Lane Length L_D	200	
Freeway Volume, V_F	3884	
Ramp Volume, V_R	513	
Freeway Free-Flow Speed, S_{FF}	55.0	
Ramp Free-Flow Speed, S_{FR}	45.0	

Downstream Adj Ramp

☑ Yes   ☐ On

☐ No   ☑ Off

L_{down} =   1400   ft

V_D =   373   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3884	0.90	Level	5	0	0.976	1.00	4423
Ramp	513	0.90	Level	6	0	0.971	1.00	587
UpStream								
DownStream	373	0.90	Level	18	0	0.917	1.00	452

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)   Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   571.16   (Equation 13-12 or 13-13)

P_{FD} =   0.622   using Equation (Exhibit 13-7)

V_{12} =   2975   pc/h

V_3 or V_{av34} 1448   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	4423	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	3836	Exhibit 13-8	6750	No
V_R	587	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2975	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) — Merge

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R =   28.0 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination — Merge

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination — Diverge

D_s =   0.351 (Exhibit 13-12)

S_R =   50.4 mph (Exhibit 13-12)

S_0 =   58.6 mph (Exhibit 13-12)

S =   52.8 mph (Exhibit 13-13)

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F-4342

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1240-EB Off to Mt. Pleasant St
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp

Upstream Adj Ramp
☐ Yes   ☐ On
☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N   3
Ramp Number of Lanes, N   1
Acceleration Lane Length, L_A
Deceleration Lane Length L_D 175
Freeway Volume, V_F 4885
Ramp Volume, V_R 817
Freeway Free-Flow Speed, S_{FF} 55.0
Ramp Free-Flow Speed, S_{FR} 45.0

Downstream Adj Ramp
☐ Yes   ☐ On
☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4885	0.90	Level	6	0	0.971	1.00	5591
Ramp	817	0.90	Level	10	0	0.952	1.00	953
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   0.576 using Equation (Exhibit 13-7)
V_{12} =   3626 pc/h
V_3 or V_{av34} 1965 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	5591	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	4638	Exhibit 13-8	6750	No
V_R	953	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	3626	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   33.9 (pc/mi/ln)
LOS =   D (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.384 (Exhibit 13-12)
S_R =   50.0 mph (Exhibit 13-12)
S_0 =   56.6 mph (Exhibit 13-12)
S =   52.1 mph (Exhibit 13-13)

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F-4343

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1240-EB Off to Mt. Pleasant St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp		
☐ Yes	☐ On	
☑ No	☐ Off	
L_{up} =	ft	
V_u =	veh/h	

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	175
Freeway Volume, V_F	3371
Ramp Volume, V_R	373
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp		
☐ Yes	☐ On	
☑ No	☐ Off	
L_{down} =	ft	
V_D =	veh/h	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3371	0.90	Level	5	0	0.976	1.00	3839
Ramp	373	0.90	Level	18	0	0.917	1.00	452
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} | Estimation of v_{12}

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 0.643 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 2631 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 1208 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	3839	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	3387	Exhibit 13-8	6750	No
V_R	452	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	2631	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) | Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 25.3 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = C (Exhibit 13-2)

Speed Determination | Speed Determination

Merge	Diverge
M_S = (Exibit 13-11)	D_S = 0.339 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 50.6 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = 59.5 mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 53.1 mph (Exhibit 13-13)

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F-4344

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2038 Build-River Center Site	Junction	EB Off to US-17 NB
Analysis Time Period:	AM Peak	Segment ID	1250
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	4,068	2,592	1,476
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	7%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.97	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,544	1,490	1,673
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.69	0.66	0.76
Density, D_{MD} (pc/mi/ln)	27.0	26.1	29.3
LOS	C	C	D

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2038 Build-River Center Site	Junction	EB Off to US-17 NB
Analysis Time Period:	PM Peak	Segment ID	1250
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,998	2,234	764
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	5%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,138	1,272	879
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.51	0.57	0.40
Density, D_{MD} (pc/mi/ln)	19.9	22.3	15.4
LOS	B	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

F-4346

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins	From/To	1260 - US17 NB to Cypress St
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2592	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	7	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ 1490   pc/h/ln

S	55.0	mph
$D = v_p / S$	27.1	pc/mi/ln
LOS	D	

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S		mph
$D = v_p / S$		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4347

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 EB
Agency or Company	Atkins	From/To	1260 - US17 NB to Cypress St
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2234	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	5	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.976

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1272   pc/h/ln

S   55.0   mph

D = v_p / S   23.1   pc/mi/ln

LOS   C

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4348

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2038 Build-River Center Site	Junction	EB On from Cypress St
Analysis Time Period:	AM Peak	Segment ID	1270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,592	2,711	119
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	6%	14%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.93
Demand Flow Rate, v_p (pc/h/ln)	1,490	1,034	141
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.66	0.46	0.07
Density, D_{MD} (pc/mi/ln)	26.1	18.1	2.5
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

F-4349

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2038 Build-River Center Site	Junction	EB On from Cypress St
Analysis Time Period:	PM Peak	Segment ID	1270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,234	2,435	201
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	4%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,272	920	231
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.57	0.41	0.11
Density, D_{MD} (pc/mi/ln)	22.3	16.1	4.0
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*	
Agency or Company	*Atkins*	
Date Performed	*7/25/2014*	
Analysis Time Period	*AM Peak*	

Site Information

Highway/Direction of Travel	*I-26 EB*
From/To	*1280 - East Of Cypress*
Jurisdiction	
Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*2711*	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	*0.90*	
%Trucks and Buses, P_T	*6*	
%RVs, P_R	*0*	
General Terrain:	*Level*	
Grade % Length	*mi*	
Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*
E_T	*1.5*

E_R	*1.2*
$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1034*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*18.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4351

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	I-26 EB
From/To	1280 - East Of Cypress
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2435	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	4	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length		mi
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R		1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$		0.980

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	920	pc/h/ln
S	55.0	mph
D = v_p / S	16.7	pc/mi/ln
LOS	B	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4352

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 Build-River Center Site	Junction	WB Off to US-17 NB
Analysis Time Period:	AM Peak	Segment ID	2010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,513	1,435	2,078
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	5%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,000	545	1,178
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.44	0.24	0.54
Density, D_{MD} (pc/mi/ln)	17.5	9.5	20.6
LOS	B	A	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

F-4353

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 Build-River Center Site	Junction	WB Off to US-17 NB
Analysis Time Period:	PM Peak	Segment ID	2010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	4,428	2,172	2,256
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,255	821	1,272
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.56	0.36	0.58
Density, D_{MD} (pc/mi/ln)	22.0	14.4	22.3
LOS	C	B	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS
ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 Build-River Center Site	Junction	WB Off to Romney St
Analysis Time Period:	AM Peak	Segment ID	2020
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,435	1,205	230
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	5%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.98
Demand Flow Rate, v_p (pc/h/ln)	545	686	262
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.24	0.30	0.12
Density, D_{MD} (pc/mi/ln)	9.5	12.0	4.6
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 Build-River Center Site	Junction	WB Off to Romney St
Analysis Time Period:	PM Peak	Segment ID	2020
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,172	2,021	151
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	821	1,145	174
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.36	0.51	0.08
Density, D_{MD} (pc/mi/ln)	14.4	20.0	3.0
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins	From/To	2025- Romney Off to US17 SB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1205	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	5	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.976

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) **686** pc/h/ln

S   55.0   mph

D = v_p / S   12.5   pc/mi/ln

LOS   B

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4357

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Project Description   Navy Base ICTF

Site Information

Highway/Direction of Travel	I-26 WB
From/To	2025- Romney Off to US17 SB On
Jurisdiction	
Analysis Year	2038 Build - River Center Site

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2021	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	0.90	
%Trucks and Buses, P_T	4	
%RVs, P_R	0	
General Terrain:	Level	
Grade % Length	mi	
Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.980

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	2	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	55.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	55.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1145	pc/h/ln
S	55.0	mph
D = v_p / S	20.8	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service speed
DDHV - Directional design hour volume

S   - Speed
D   - Density
FFS - Free-flow speed
BFFS - Base free-flow

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-4358

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 Build-River Center Site	Junction	WB On from US-17 SB
Analysis Time Period:	AM Peak	Segment ID	2030
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,205	2,473	1,268
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	6%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.97	0.97
Demand Flow Rate, v_p (pc/h/ln)	686	943	1,458
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.30	0.42	0.66
Density, D_{MD} (pc/mi/ln)	12.0	16.5	25.5
LOS	B	B	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1) + P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF \cdot N \cdot f_{HV} \cdot f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175 \cdot v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 Build-River Center Site	Junction	WB On from US-17 SB
Analysis Time Period:	PM Peak	Segment ID	2030
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,021	3,272	1,251
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,145	1,236	1,432
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.51	0.55	0.65
Density, D_{MD} (pc/mi/ln)	20.0	21.6	25.1
LOS	B	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF \cdot N \cdot f_{HV} \cdot f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175 \cdot v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Project Description   Navy Base ICTF

Site Information

Freeway/Dir of Travel	I-26 WB
Junction	2040 - WB On from Meeting
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On
☒ No   ☐ Off

$L_{up} =$ _____ ft

$V_u =$ _____ veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	600
Deceleration Lane Length L_D	
Freeway Volume, V_F	2473
Ramp Volume, V_R	396
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On
☒ No   ☐ Off

$L_{down} =$ _____ ft

$V_D =$ _____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2473	0.90	Level	6	0	0.971	1.00	2830
Ramp	396	0.90	Level	10	0	0.952	1.00	462
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge:

$V_{12} = V_F (P_{FM})$

$L_{EQ} =$ _____ (Equation 13-6 or 13-7)

$P_{FM} =$ 0.594 using Equation (Exhibit 13-6)

$V_{12} =$ 1682 pc/h

V_3 or V_{av34} = 1148 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☒ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☒ No

If Yes, $V_{12a} =$ _____ pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$V_{12} = V_R + (V_F - V_R)P_{FD}$

$L_{EQ} =$ _____ (Equation 13-12 or 13-13)

$P_{FD} =$ _____ using Equation (Exhibit 13-7)

$V_{12} =$ _____ pc/h

V_3 or V_{av34} = _____ pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, $V_{12a} =$ _____ pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

Merge:

	Actual	Capacity	LOS F?
V_{FO}	3292	Exhibit 13-8	No

Diverge:

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

Merge:

	Actual	Max Desirable	Violation?
V_{R12}	2144	Exhibit 13-8 4600:All	No

Diverge:

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge:

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

$D_R =$ 18.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Diverge:

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

$D_R =$ _____ (pc/mi/ln)

LOS = _____ (Exhibit 13-2)

Speed Determination

Merge:

$M_S =$ 0.300 (Exibit 13-11)

$S_R =$ 51.1 mph (Exhibit 13-11)

$S_0 =$ 52.7 mph (Exhibit 13-11)

$S =$ 51.6 mph (Exhibit 13-13)

Diverge:

$D_s =$ _____ (Exhibit 13-12)

$S_R =$ _____ mph (Exhibit 13-12)

$S_0 =$ _____ mph (Exhibit 13-12)

$S =$ _____ mph (Exhibit 13-13)

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F-4361

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information
Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2040 - WB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☒ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	600
Deceleration Lane Length L_D	
Freeway Volume, V_F	3272
Ramp Volume, V_R	785
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☒ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3272	0.90	Level	4	0	0.980	1.00	3708
Ramp	785	0.90	Level	4	0	0.980	1.00	890
UpStream								
DownStream								

Merge Areas
Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.594   using Equation (Exhibit 13-6)

V_{12} =   2204 pc/h

V_3 or V_{av34} 1504 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☒ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☒ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	4598	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	3094	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   25.4 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S =   0.353 (Exibit 13-11)

S_R =   50.4 mph (Exhibit 13-11)

S_0 =   51.4 mph (Exhibit 13-11)

S =   50.7 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4362

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	AJR		Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins		From/To	2050 - Meeting to Mt Pleasant
Date Performed	7/25/2014		Jurisdiction	
Analysis Time Period	AM Peak		Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2869	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	5	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.976

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ **1089**   pc/h/ln

S	55.0	mph
D = v_p / S	19.8	pc/mi/ln
LOS	C	

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4363

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins	From/To	2050 - Meeting to Mt Pleasant
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	4057	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	5	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.976

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	1540	pc/h/ln	Design LOS		
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	55.0	mph	S		mph
D = v_p / S	28.0	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	D		Required Number of Lanes, N		

Glossary

		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service speed	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-4364

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2060 - WB On from Mt Pleasant
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On
☒ No ☐ Off

L_{up} = ____ ft

V_u = ____ veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	275
Deceleration Lane Length L_D	
Freeway Volume, V_F	2869
Ramp Volume, V_R	322
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On
☒ No ☐ Off

L_{down} = ____ ft

V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2869	0.90	Level	5	0	0.976	1.00	3267
Ramp	322	0.90	Level	10	0	0.952	1.00	376
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = ____ (Equation 13-6 or 13-7)

P_{FM} = 0.585 using Equation (Exhibit 13-6)

V_{12} = 1912 pc/h

V_3 or V_{av34} = 1355 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☒ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☒ No

If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = ____ (Equation 13-12 or 13-13)

P_{FD} = ____ using Equation (Exhibit 13-7)

V_{12} = ____ pc/h

V_3 or V_{av34} = ____ pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	3643	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	2288	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 21.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = ____ (pc/mi/ln)

LOS = ____ (Exhibit 13-2)

Speed Determination (Merge)

M_S = 0.335 (Exibit 13-11)

S_R = 50.6 mph (Exhibit 13-11)

S_0 = 51.9 mph (Exhibit 13-11)

S = 51.1 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s = ____ (Exhibit 13-12)

S_R = ____ mph (Exhibit 13-12)

S_0 = ____ mph (Exhibit 13-12)

S = ____ mph (Exhibit 13-13)

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F-4365

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2060 - WB On from Mt Pleasant
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ___ ft

V_u = ___ veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	275
Deceleration Lane Length L_D	
Freeway Volume, V_F	4057
Ramp Volume, V_R	767
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ___ ft

V_D = ___ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4057	0.90	Level	5	0	0.976	1.00	4620
Ramp	767	0.90	Level	4	0	0.980	1.00	869
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = ___ (Equation 13-6 or 13-7)

P_{FM} = 0.585 using Equation (Exhibit 13-6)

V_{12} = 2704 pc/h

V_3 or V_{av34} = 1916 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = ___ pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = ___ (Equation 13-12 or 13-13)

P_{FD} = ___ using Equation (Exhibit 13-7)

V_{12} = ___ pc/h

V_3 or V_{av34} = ___ pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = ___ pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	5489	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	3573	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 31.2 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = ___ (pc/mi/ln)

LOS = ___ (Exhibit 13-2)

Speed Determination — Merge

M_S = 0.435 (Exibit 13-11)

S_R = 49.3 mph (Exhibit 13-11)

S_0 = 49.9 mph (Exhibit 13-11)

S = 49.5 mph (Exhibit 13-13)

Speed Determination — Diverge

D_s = ___ (Exhibit 13-12)

S_R = ___ mph (Exhibit 13-12)

S_0 = ___ mph (Exhibit 13-12)

S = ___ mph (Exhibit 13-13)

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F-4366

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2070 - WB On from Heriot
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On
☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	1165
Deceleration Lane Length L_D	
Freeway Volume, V_F	3191
Ramp Volume, V_R	291
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On
☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3191	0.90	Level	6	0	0.971	1.00	3652
Ramp	291	0.90	Level	21	0	0.905	1.00	357
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge Areas)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = 0.610 using Equation (Exhibit 13-6)
V_{12} = 2228 pc/h
V_3 or V_{av34} = 1424 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge Areas)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} = pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	4009	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	2585	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 18.2 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination — Merge

M_S = 0.268 (Exibit 13-11)
S_R = 51.5 mph (Exhibit 13-11)
S_0 = 51.7 mph (Exhibit 13-11)
S = 51.6 mph (Exhibit 13-13)

Speed Determination — Diverge

D_s = (Exhibit 13-12)
S_R = mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

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F-4367

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Freeway/Dir of Travel	I-26 WB
Junction	2070 - WB On from Heriot
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp
- [ ] Yes [ ] On
- [x] No [ ] Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	1165
Deceleration Lane Length L_D	
Freeway Volume, V_F	4824
Ramp Volume, V_R	487
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
- [ ] Yes [ ] On
- [x] No [ ] Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	4824	0.90	Level	5	0	0.976	1.00	5494
Ramp	487	0.90	Level	11	0	0.948	1.00	571
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$V_{12} = V_F (P_{FM})$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} = 0.610 using Equation (Exhibit 13-6)
V_{12} = 3352 pc/h
V_3 or V_{av34} = 2142 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? [ ] Yes [x] No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 [ ] Yes [x] No
If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   using Equation (Exhibit 13-7)
V_{12} =   pc/h
V_3 or V_{av34} =   pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? [ ] Yes [ ] No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 [ ] Yes [ ] No
If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	6065	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	3923	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = 28.5 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Speed Determination (Merge)

M_S = 0.413 (Exibit 13-11)
S_R = 49.6 mph (Exhibit 13-11)
S_0 = 49.1 mph (Exhibit 13-11)
S = 49.4 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =   (Exhibit 13-12)
S_R =   mph (Exhibit 13-12)
S_0 =   mph (Exhibit 13-12)
S =   mph (Exhibit 13-13)

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F-4368

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2080 - Heriot to PAR*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*3482*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*6*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

			### Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   *1328*   pc/h/ln

S	*60.0*	mph
D = v_p / S	*22.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4369

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2080 - Heriot to PAR*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 Build - River Center Site*

Project Description	*Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*5311*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	2016	pc/h/ln
S	*56.9*	mph
D = v_p / S	*35.5*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

F-4370

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2090-WB Off to PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site
Project Description Navy Base ICTF			

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	340
Freeway Volume, V_F	3482
Ramp Volume, V_R	632
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3482	0.90	Level	6	0	0.971	1.00	3985
Ramp	632	0.90	Level	41	0	0.830	1.00	846
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   0.621 using Equation (Exhibit 13-7)

V_{12} =   2797 pc/h

V_3 or V_{av34} 1188 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	3985	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3139	Exhibit 13-8	6900	No
V_R	846	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	2797	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   25.2 (pc/mi/ln)

LOS =   C (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.374 (Exhibit 13-12)

S_R =   53.3 mph (Exhibit 13-12)

S_0 =   65.1 mph (Exhibit 13-12)

S =   56.3 mph (Exhibit 13-13)

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F-4371

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2090-WB Off to PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On
☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	340
Freeway Volume, V_F	5311
Ramp Volume, V_R	319
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On
☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5311	0.90	Level	5	0	0.976	1.00	6049
Ramp	319	0.90	Level	36	0	0.847	1.00	418
UpStream								
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   0.590 using Equation (Exhibit 13-7)
V_{12} =   3738 pc/h
V_3 or V_{av34} 2311 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	6049	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5631	Exhibit 13-8	6900	No
V_R	418	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	3738	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   33.3 (pc/mi/ln)
LOS =   D (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.336 (Exhibit 13-12)
S_R =   54.0 mph (Exhibit 13-12)
S_0 =   60.7 mph (Exhibit 13-12)
S =   56.4 mph (Exhibit 13-13)

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F-4372

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*
Agency or Company	*Atkins*
Date Performed	*7/25/2014*
Analysis Time Period	*AM Peak*

Project Description   *Navy Base ICTF*

Site Information

Highway/Direction of Travel	*I-26 WB*
From/To	*2100 - PAR Off to PAR On*
Jurisdiction	
Analysis Year	*2038 Build - River Center Site*

☑ Oper.(LOS)　　　　☐ Des.(N)　　　　☐ Planning Data

Flow Inputs

Volume, V	*2850*	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	*0.90*	
%Trucks and Buses, P_T	*8*	
%RVs, P_R	*0*	
General Terrain:	*Level*	
Grade % Length	*mi*	
Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*
E_T	*1.5*

E_R	*1.2*
$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$	*1098*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*18.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4373

BASIC FREEWAY SEGMENTS WORKSHEET

General Information			Site Information	
Analyst	AJR		Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins		From/To	2100 - PAR Off to PAR On
Date Performed	7/25/2014		Jurisdiction	
Analysis Time Period	PM Peak		Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	4992	veh/h	Peak-Hour Factor, PHF	0.90
AADT		veh/day	%Trucks and Buses, P_T	7
Peak-Hr Prop. of AADT, K			%RVs, P_R	0
Peak-Hr Direction Prop, D			General Terrain:	Level
DDHV = AADT x K x D		veh/h	Grade % Length mi	
			Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = $1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs | ### Calc Speed Adj and FFS

Lane Width		ft		
Rt-Side Lat. Clearance		ft	f_{LW}	mph
Number of Lanes, N	3		f_{LC}	mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment	mph
FFS (measured)	60.0	mph	FFS 60.0	mph
Base free-flow Speed, BFFS		mph		

LOS and Performance Measures | ### Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1914   pc/h/ln

S   58.2   mph

D = v_p / S   32.9   pc/mi/ln

LOS   D

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4374

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ΛTKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	WB US-52 & PAR Off Ramp
Analysis Year	2038 Build-River Center Site	Junction	US-52 & PAR WB Ramp Merge
Analysis Time Period:	AM Peak	Segment ID	2105
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	988	1,089	101
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	8%	41%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.96	0.83
Demand Flow Rate, v_p (pc/h/ln)	1,125	1,258	135
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.51	0.57	0.06
Density, D_{MD} (pc/mi/ln)	19.7	22.0	2.4
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	WB US-52 & PAR Off Ramp
Analysis Year	2038 Build-River Center Site	Junction	US-52 & PAR WB Ramp Merge
Analysis Time Period:	PM Peak	Segment ID	2105
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	352	636	284
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	11%	22%	36%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.90	0.85
Demand Flow Rate, v_p (pc/h/ln)	413	784	372
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.19	0.36	0.18
Density, D_{MD} (pc/mi/ln)	7.2	13.7	6.5
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Project Description   Navy Base ICTF

Site Information

Freeway/Dir of Travel	I-26 WB
Junction	2110 - WB On from US-52 & PAR
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	180
Deceleration Lane Length L_D	
Freeway Volume, V_F	2850
Ramp Volume, V_R	1089
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2850	0.90	Level	8	0	0.962	1.00	3293
Ramp	1089	0.90	Level	8	0	0.962	1.00	1258
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   0.583   using Equation (Exhibit 13-6)

V_{12} =   1918   pc/h

V_3 or V_{av34} 1375   pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   using Equation (Exhibit 13-7)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	4551	Exhibit 13-8	No

Capacity Checks

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	3176	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   28.5 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination

M_S =   0.398 (Exibit 13-11)

S_R =   52.8 mph (Exhibit 13-11)

S_0 =   56.8 mph (Exhibit 13-11)

S =   54.0 mph (Exhibit 13-13)

Speed Determination

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4377

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2110 - WB On from US-52 & PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N = 3	☐ Yes ☐ On
	Ramp Number of Lanes, N = 1	
☒ No ☐ Off	Acceleration Lane Length, L_A = 180	☒ No ☐ Off
	Deceleration Lane Length L_D =	
L_{up} = ft	Freeway Volume, V_F = 4992	L_{down} = ft
	Ramp Volume, V_R = 636	
V_u = veh/h	Freeway Free-Flow Speed, S_{FF} = 60.0	V_D = veh/h
	Ramp Free-Flow Speed, S_{FR} = 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4992	0.90	Level	7	0	0.966	1.00	5741
Ramp	636	0.90	Level	22	0	0.901	1.00	784
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 0.583 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 3344 pc/h	V_{12} = pc/h
V_3 or V_{av34} = 2397 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} = pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☒ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☒ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	6525	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	4128	Exhibit 13-8 4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge:
$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 36.2 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Diverge:
$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

Merge:

M_S = 0.547 (Exibit 13-11)

S_R = 50.2 mph (Exhibit 13-11)

S_0 = 52.9 mph (Exhibit 13-11)

S = 51.1 mph (Exhibit 13-13)

Diverge:

D_s = (Exhibit 13-12)

S_R = mph (Exhibit 13-12)

S_0 = mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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F-4378

BASIC FREEWAY SEGMENTS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins	From/To	2120 - US-52 to Cosgrove
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3939	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	8	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]	0.962

Speed Inputs | Calc Speed Adj and FFS

Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures | Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) = 1517 pc/h/ln

S = 60.0 mph

D = v_p / S = 25.3 pc/mi/ln

LOS = C

Design (N)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) pc/h/ln

S mph

D = v_p / S pc/mi/ln

Required Number of Lanes, N

Glossary | Factor Location

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service speed   BFFS - Base free-flow
DDHV - Directional design hour volume

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

F-4379

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*
Agency or Company	*Atkins*
Date Performed	*7/25/2014*
Analysis Time Period	*PM Peak*

Site Information

Highway/Direction of Travel	*I-26 WB*
From/To	*2120 - US-52 to Cosgrove*
Jurisdiction	
Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*5628*	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	*0.90*	
%Trucks and Buses, P_T	*7*	
%RVs, P_R	*0*	
General Terrain:	*Level*	
Grade % Length	*mi*	
Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*
E_T	*1.5*

E_R	*1.2*
$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2157*	pc/h/ln
S	*54.4*	mph
D = v_p / S	*39.7*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)
Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service speed	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4380

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2130-WB Off to Cosgrove NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp
☐ Yes   ☐ On
☑ No   ☐ Off
L_{up} =   ft
V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	525
Freeway Volume, V_F	3939
Ramp Volume, V_R	432
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes   ☐ On
☑ No   ☐ Off
L_{down} =   ft
V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3939	0.90	Level	8	0	0.962	1.00	4552
Ramp	432	0.90	Level	13	0	0.939	1.00	511
UpStream								
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12} (Merge Areas)

$V_{12} = V_F (P_{FM})$

L_{EQ} =   (Equation 13-6 or 13-7)
P_{FM} =   using Equation   (Exhibit 13-6)
V_{12} =   pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge Areas)

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} =   (Equation 13-12 or 13-13)
P_{FD} =   0.623 using Equation (Exhibit 13-7)
V_{12} =   3027 pc/h
V_3 or V_{av34} 1525 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	4552	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4041	Exhibit 13-8	6900	No
V_R	511	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	3027	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =   (pc/mi/ln)
LOS =   (Exhibit 13-2)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =   25.6 (pc/mi/ln)
LOS =   C (Exhibit 13-2)

Speed Determination

M_S =   (Exibit 13-11)
S_R =   mph (Exhibit 13-11)
S_0 =   mph (Exhibit 13-11)
S =   mph (Exhibit 13-13)

D_s =   0.344 (Exhibit 13-12)
S_R =   53.8 mph (Exhibit 13-12)
S_0 =   63.8 mph (Exhibit 13-12)
S =   56.8 mph (Exhibit 13-13)

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F-4381

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2130-WB Off to Cosgrove NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	525
Freeway Volume, V_F	5628
Ramp Volume, V_R	394
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5628	0.90	Level	7	0	0.966	1.00	6472
Ramp	394	0.90	Level	13	0	0.939	1.00	466
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} | ### *Estimation of v_{12}*

$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} =　(Equation 13-6 or 13-7)	L_{EQ} =　(Equation 13-12 or 13-13)
P_{FM} =　using Equation (Exhibit 13-6)	P_{FD} =　0.577　using Equation (Exhibit 13-7)
V_{12} =　pc/h	V_{12} =　3930　pc/h
V_3 or V_{av34}　pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34}　2542　pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes,V_{12a} =　pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} =　pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | ### *Capacity Checks*

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity		LOS F?
V_F	6472	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	6006	Exhibit 13-8	6900	No
V_R	466	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | ### *Flow Entering Diverge Influence Area*

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	3930	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) | ### *Level of Service Determination (if not F)*

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R =　(pc/mi/ln)

LOS =　(Exhibit 13-2)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R =　33.3 (pc/mi/ln)

LOS =　D (Exhibit 13-2)

Speed Determination | ### *Speed Determination*

M_S =　(Exibit 13-11)

S_R =　mph (Exhibit 13-11)

S_0 =　mph (Exhibit 13-11)

S =　mph (Exhibit 13-13)

D_s =　0.340 (Exhibit 13-12)

S_R =　53.9 mph (Exhibit 13-12)

S_0 =　59.8 mph (Exhibit 13-12)

S =　56.1 mph (Exhibit 13-13)

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F-4382

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	I-26 WB
From/To	2135-Cosg NB Off to Cosg NB On
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	3507	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	8	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00		E_R	1.2
E_T	1.5		$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1351	pc/h/ln
S	60.0	mph
D = v_p / S	22.5	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010™   Version 6.41   Generated: 12/9/2014   2:20 PM

F-4383

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Highway/Direction of Travel	I-26 WB
From/To	2135-Cosg NB Off to Cosg NB On
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	5234	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	7	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R		1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966	

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	2006	pc/h/ln
S	57.0	mph
D = v_p / S	35.2	pc/mi/ln
LOS	E	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4384

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency/Company	Atkins	Weaving Segment Location	2140 - Cosgrove NB to Cos. SB
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	560ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3108	0.90	8	0	1.5	1.2	0.962	1.00	3591
V_{RF}	874	0.90	19	0	1.5	1.2	0.913	1.00	1063
V_{FR}	399	0.90	28	0	1.5	1.2	0.877	1.00	505
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3591							V =	5159
V_W	1568								
VR	0.304								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1568 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1743 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	273 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2016 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	201

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5159 pc/h	Weaving intensity factor, W	0.621
Weaving segment capacity, c_w	7354 veh/h	Weaving segment speed, S	42.6 mph
Weaving segment v/c ratio	0.675	Average weaving speed, S_W	42.8 mph
Weaving segment density, D	30.3 pc/mi/ln	Average non-weaving speed, S_{NW}	42.5 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5626 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4385

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency/Company	Atkins	Weaving Segment Location	2140 - Cosgrove NB to Cos. SB
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	560ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4343	0.90	7	0	1.5	1.2	0.966	1.00	4994
V_{RF}	800	0.90	18	0	1.5	1.2	0.917	1.00	969
V_{FR}	891	0.90	11	0	1.5	1.2	0.948	1.00	1044
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	4994							V =	7007
V_W	2013								
VR	0.287								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2013 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	2188 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	562 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2750 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	280

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	7007 pc/h	Weaving intensity factor, W	0.793
Weaving segment capacity, c_w	7443 veh/h	Weaving segment speed, S	37.9 mph
Weaving segment v/c ratio	0.910	Average weaving speed, S_W	40.1 mph
Weaving segment density, D	46.2 pc/mi/ln	Average non-weaving speed, S_{NW}	37.1 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5448 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4386

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	*AJR*
Agency or Company	*Atkins*
Date Performed	*7/25/2014*
Analysis Time Period	*AM Peak*

Project Description *Navy Base ICTF*

Site Information

Highway/Direction of Travel	*I-26 WB*
From/To	*2145-Cosg SB Off to Cosg SB On*
Jurisdiction	
Analysis Year	*2038 Build - River Center Site*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3982*	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	*0.90*
%Trucks and Buses, P_T	*8*
%RVs, P_R	*0*
General Terrain:	*Level*
Grade % Length	*mi*
Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*
E_T	*1.5*

E_R	*1.2*
$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1534	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.6*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4387

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2145-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 Build - River Center Site*

Project Description	*Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5143*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*7*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft			
Number of Lanes, N	*3*		f_{LW}		mph
Total Ramp Density, TRD		ramps/mi	f_{LC}		mph
			TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures / Design (N)

Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1971*	pc/h/ln	Design LOS		
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*57.5*	mph	S		mph
D = v_p / S	*34.3*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*D*		Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM] Version 6.41   Generated: 12/9/2014   2:23 PM

F-4388

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2150 - WB On from Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp		
☐ Yes	☐ On	
☑ No	☐ Off	
L_{up} =	ft	
V_u =	veh/h	

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	425
Deceleration Lane Length L_D	
Freeway Volume, V_F	3982
Ramp Volume, V_R	184
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp		
☑ Yes	☐ On	
☐ No	☑ Off	
L_{down} =	2390 ft	
V_D =	371 veh/h	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3982	0.90	Level	8	0	0.962	1.00	4601
Ramp	184	0.90	Level	24	0	0.893	1.00	229
UpStream								
DownStream	371	0.90	Level	21	0	0.905	1.00	456

Merge Areas	**Diverge Areas**

Estimation of v_{12} (Merge) / Estimation of v_{12} (Diverge)

Merge	Diverge
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = 2940.51 (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = 0.599 using Equation (Exhibit 13-6)	P_{FD} = using Equation (Exhibit 13-7)
V_{12} = 2755 pc/h	V_{12} = pc/h
V_3 or V_{av34} 1846 pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No	Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4830	Exhibit 13-8		No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area / Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2984	Exhibit 13-8	4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F)

Merge	Diverge
$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = 26.0 (pc/mi/ln)	D_R = (pc/mi/ln)
LOS = C (Exhibit 13-2)	LOS = (Exhibit 13-2)

Speed Determination

Merge	Diverge
M_S = 0.360 (Exibit 13-11)	D_s = (Exhibit 13-12)
S_R = 53.5 mph (Exhibit 13-11)	S_R = mph (Exhibit 13-12)
S_0 = 55.2 mph (Exhibit 13-11)	S_0 = mph (Exhibit 13-12)
S = 54.1 mph (Exhibit 13-13)	S = mph (Exhibit 13-13)

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F-4389

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2150 - WB On from Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☒ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	425
Deceleration Lane Length L_D	
Freeway Volume, V_F	5143
Ramp Volume, V_R	373
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☒ Yes   ☐ On

☐ No   ☒ Off

L_{down} =   2390   ft

V_D =   447 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5143	0.90	Level	7	0	0.966	1.00	5914
Ramp	373	0.90	Level	10	0	0.952	1.00	435
UpStream								
DownStream	447	0.90	Level	15	0	0.930	1.00	534

Merge Areas | Diverge Areas

Estimation of v_{12} | Estimation of v_{12}

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =	3443.50 (Equation 13-6 or 13-7)
P_{FM} =	0.607 using Equation (Exhibit 13-6)
V_{12} =	3592 pc/h
V_3 or V_{av34}	2322 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☒ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☒ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =	(Equation 13-12 or 13-13)
P_{FD} =	using Equation (Exhibit 13-7)
V_{12} =	pc/h
V_3 or V_{av34}	pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks | Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}	6349	Exhibit 13-8	No

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	4027	Exhibit 13-8 4600:All	No

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) | Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   34.0 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Speed Determination | Speed Determination

M_S =   0.502 (Exibit 13-11)

S_R =   51.0 mph (Exhibit 13-11)

S_0 =   53.3 mph (Exhibit 13-11)

S =   51.8 mph (Exhibit 13-13)

D_s =   (Exhibit 13-12)

S_R =   mph (Exhibit 13-12)

S_0 =   mph (Exhibit 13-12)

S =   mph (Exhibit 13-13)

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F-4390

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Freeway/Dir of Travel	I-26 WB
Junction	2160-WB Off to Dorchester
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp
- [x] Yes   [x] On
- [ ] No   [ ] Off

L_{up} =   2390 ft

V_u =   184 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	425
Freeway Volume, V_F	4166
Ramp Volume, V_R	371
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
- [ ] Yes   [ ] On
- [x] No   [ ] Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4166	0.90	Level	7	0	0.966	1.00	4791
Ramp	371	0.90	Level	21	0	0.905	1.00	456
UpStream	184	0.90	Level	24	0	0.893	1.00	229
DownStream								

Merge Areas / Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =	(Equation 13-6 or 13-7)
P_{FM} =	using Equation (Exhibit 13-6)
V_{12} =	pc/h
V_3 or V_{av34}	pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h?	[ ] Yes [ ] No
Is V_3 or V_{av34} > 1.5 * V_{12}/2	[ ] Yes [ ] No
If Yes, V_{12a} =	pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =	1562.75 (Equation 13-12 or 13-13)
P_{FD} =	0.619 using Equation (Exhibit 13-7)
V_{12} =	3140 pc/h
V_3 or V_{av34}	1651 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h?	[ ] Yes [x] No
Is V_3 or V_{av34} > 1.5 * V_{12}/2	[ ] Yes [x] No
If Yes, V_{12a} =	pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks (Diverge)

	Actual	Capacity		LOS F?
V_F	4791	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4335	Exhibit 13-8	6900	No
V_R	456	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3140	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =	(pc/mi/ln)
LOS =	(Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =	27.4 (pc/mi/ln)
LOS =	C (Exhibit 13-2)

Speed Determination (Merge)

M_S =	(Exibit 13-11)
S_R =	mph (Exhibit 13-11)
S_0 =	mph (Exhibit 13-11)
S =	mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s =	0.339 (Exhibit 13-12)
S_R =	53.9 mph (Exhibit 13-12)
S_0 =	63.3 mph (Exhibit 13-12)
S =	56.8 mph (Exhibit 13-13)

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F-4391

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2160-WB Off to Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description Navy Base ICTF			

Inputs

Upstream Adj Ramp				Downstream Adj Ramp	
☑ Yes ☑ On	Freeway Number of Lanes, N	3		☐ Yes ☐ On	
	Ramp Number of Lanes, N	1			
☐ No ☐ Off	Acceleration Lane Length, L_A			☑ No ☐ Off	
	Deceleration Lane Length L_D	425			
L_{up} = 2390 ft	Freeway Volume, V_F	5516		L_{down} = ft	
	Ramp Volume, V_R	447			
V_u = 373 veh/h	Freeway Free-Flow Speed, S_{FF}	60.0		V_D = veh/h	
	Ramp Free-Flow Speed, S_{FR}	45.0			

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5516	0.90	Level	6	0	0.971	1.00	6313
Ramp	447	0.90	Level	15	0	0.930	1.00	534
UpStream	373	0.90	Level	10	0	0.952	1.00	435
DownStream								

Merge Areas	Diverge Areas
Estimation of v_{12}	**Estimation of v_{12}**

Merge Areas	Diverge Areas
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = 2477.01 (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 0.581 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3890 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 2423 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6313	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5779	Exhibit 13-8	6900	No
V_R	534	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3890	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R =   33.9 (pc/mi/ln)

LOS =   D (Exhibit 13-2)

Speed Determination

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination

D_s =   0.346 (Exhibit 13-12)

S_R =   53.8 mph (Exhibit 13-12)

S_0 =   60.3 mph (Exhibit 13-12)

S =   56.1 mph (Exhibit 13-13)

HCS2010™   Version 6.41   Generated: 12/9/2014   2:31 PM

F-4392

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins	From/To	2165-Dorches Off to Dorches On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

			Peak-Hour Factor, PHF	0.90
Volume, V	3795	veh/h	%Trucks and Buses, P_T	7
AADT		veh/day	%RVs, P_R	0
Peak-Hr Prop. of AADT, K			General Terrain:	Level
Peak-Hr Direction Prop, D			Grade % Length	mi
DDHV = AADT x K x D		veh/h	Up/Down %	

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ 0.966	

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p) **1455** pc/h/ln

S	60.0	mph
D = v_p / S	24.3	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes   S   - Speed
V - Hourly volume   D   - Density
v_p - Flow rate   FFS - Free-flow speed
LOS   - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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F-4393

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins	From/To	2165-Dorches Off to Dorches On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	5069	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R		1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.971	

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1934	pc/h/ln
S	58.0	mph
D = v_p / S	33.4	pc/mi/ln
LOS	D	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010™   Version 6.41   Generated: 12/9/2014   2:32 PM

F-4394

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2170 - WB On from Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp
- [ ] Yes [ ] On
- [x] No   [ ] Off

L_{up} = ____ ft

V_u = ____ veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	600
Deceleration Lane Length L_D	
Freeway Volume, V_F	3795
Ramp Volume, V_R	268
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
- [ ] Yes [ ] On
- [x] No   [ ] Off

L_{down} = ____ ft

V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3795	0.90	Level	7	0	0.966	1.00	4364
Ramp	268	0.90	Level	22	0	0.901	1.00	331
UpStream								
DownStream								

Merge Areas | Diverge Areas

Estimation of v_{12} (Merge)

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = ____ (Equation 13-6 or 13-7)
P_{FM} = 0.594 using Equation (Exhibit 13-6)
V_{12} = 2594 pc/h
V_3 or V_{av34} = 1770 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? [ ] Yes [x] No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 [ ] Yes [x] No
If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12} (Diverge)

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = ____ (Equation 13-12 or 13-13)
P_{FD} = ____ using Equation (Exhibit 13-7)
V_{12} = ____ pc/h
V_3 or V_{av34} = ____ pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? [ ] Yes [ ] No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 [ ] Yes [ ] No
If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	4695	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	2925	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = 24.4 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = ____ (pc/mi/ln)
LOS = ____ (Exhibit 13-2)

Speed Determination (Merge)

M_S = 0.340 (Exibit 13-11)
S_R = 53.9 mph (Exhibit 13-11)
S_0 = 55.4 mph (Exhibit 13-11)
S = 54.5 mph (Exhibit 13-13)

Speed Determination (Diverge)

D_s = ____ (Exhibit 13-12)
S_R = ____ mph (Exhibit 13-12)
S_0 = ____ mph (Exhibit 13-12)
S = ____ mph (Exhibit 13-13)

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F-4395

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Freeway/Dir of Travel	I-26 WB
Junction	2170 - WB On from Dorchester
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp: ☐ Yes ☐ On ☒ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	600
Deceleration Lane Length L_D	
Freeway Volume, V_F	5069
Ramp Volume, V_R	591
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp: ☐ Yes ☐ On ☒ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	5069	0.90	Level	6	0	0.971	1.00	5801
Ramp	591	0.90	Level	9	0	0.957	1.00	686
UpStream								
DownStream								

Merge Areas — Estimation of v_{12}

$V_{12} = V_F (P_{FM})$
L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = 0.594 using Equation (Exhibit 13-6)
V_{12} = 3448 pc/h
V_3 or V_{av34} = 2353 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☒ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☒ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas — Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} = pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}	6487	Exhibit 13-8	No

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F		Exhibit 13-8	
$V_{FO} = V_F - V_R$		Exhibit 13-8	
V_R		Exhibit 13-10	

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}	4134	Exhibit 13-8 4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}		Exhibit 13-8	

Level of Service Determination (if not F) — Merge

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$
D_R = 33.6 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Level of Service Determination (if not F) — Diverge

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination — Merge

M_S = 0.510 (Exibit 13-11)
S_R = 50.8 mph (Exhibit 13-11)
S_0 = 53.2 mph (Exhibit 13-11)
S = 51.6 mph (Exhibit 13-13)

Speed Determination — Diverge

D_s = (Exhibit 13-12)
S_R = mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

HCS2010™ Version 6.41   Generated: 12/9/2014 2:33 PM

F-4396

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR
Agency or Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Highway/Direction of Travel	I-26 WB
From/To	2180 - Dorchester to Montague
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	4063	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	7	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.966

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

	1557	pc/h/ln
S	60.0	mph
D = v_p / S	26.0	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)

		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   2:33 PM

F-4397

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins	From/To	2180 - Dorchester to Montague
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	5660	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$ 0.971	

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   2159   pc/h/ln

S   54.3   mph

D = v_p / S   39.7   pc/mi/ln

LOS   E

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010™   Version 6.41   Generated: 12/9/2014   2:34 PM

F-4398

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information   ### Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2190-WB Off to Montague
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3		Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1		☐ Yes	☐ On
		Acceleration Lane Length, L_A				
☑ No	☐ Off	Deceleration Lane Length L_D	240		☑ No	☐ Off
		Freeway Volume, V_F	4063			
L_{up} =	ft	Ramp Volume, V_R	1141		L_{down} =	ft
		Freeway Free-Flow Speed, S_{FF}	60.0			
V_u =	veh/h	Ramp Free-Flow Speed, S_{FR}	45.0		V_D =	veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4063	0.90	Level	7	0	0.966	1.00	4672
Ramp	1141	0.90	Level	11	0	0.948	1.00	1338
UpStream								
DownStream								

Merge Areas	**Diverge Areas**

Estimation of v_{12} ### Estimation of v_{12}

$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 0.582 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3277 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 1395 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☐No	Is V_3 or V_{av34} > 2,700 pc/h? ☐Yes ☑No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☐No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐Yes ☑No
If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks   ### Capacity Checks

	Actual	Capacity	LOS F?		Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		V_F	4672	Exhibit 13-8	6900	No
				$V_{FO} = V_F - V_R$	3334	Exhibit 13-8	6900	No
				V_R	1338	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area   ### Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?		Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		V_{12}	3277	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)   ### Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$	$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$
D_R = (pc/mi/ln)	D_R = 30.3 (pc/mi/ln)
LOS = (Exhibit 13-2)	LOS = D (Exhibit 13-2)

Speed Determination   ### Speed Determination

M_S = (Exibit 13-11)	D_s = 0.418 (Exhibit 13-12)
S_R = mph (Exhibit 13-11)	S_R = 52.5 mph (Exhibit 13-12)
S_0 = mph (Exhibit 13-11)	S_0 = 64.3 mph (Exhibit 13-12)
S = mph (Exhibit 13-13)	S = 55.5 mph (Exhibit 13-13)

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F-4399

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2190-WB Off to Montague
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{up} =   ft

V_u =   veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	240
Freeway Volume, V_F	5660
Ramp Volume, V_R	1156
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes   ☐ On

☑ No   ☐ Off

L_{down} =   ft

V_D =   veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5660	0.90	Level	6	0	0.971	1.00	6478
Ramp	1156	0.90	Level	9	0	0.957	1.00	1342
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | Estimation of v_{12} (Diverge)

Estimation of v_{12}

$$V_{12} = V_F (P_{FM})$$

L_{EQ} =   (Equation 13-6 or 13-7)

P_{FM} =   using Equation   (Exhibit 13-6)

V_{12} =   pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Estimation of v_{12}

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} =   (Equation 13-12 or 13-13)

P_{FD} =   0.536 using Equation (Exhibit 13-7)

V_{12} =   4097 pc/h

V_3 or V_{av34} 2381 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} =   pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge) | Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

	Actual	Capacity	LOS F?
V_F	6478	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5136	Exhibit 13-8	6900	No
V_R	1342	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area | Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

	Actual	Max Desirable	Violation?
V_{12}	4097	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R =   (pc/mi/ln)

LOS =   (Exhibit 13-2)

Level of Service Determination (if not F)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R =   37.3 (pc/mi/ln)

LOS =   E (Exhibit 13-2)

Speed Determination (Merge)

M_S =   (Exibit 13-11)

S_R =   mph (Exhibit 13-11)

S_0 =   mph (Exhibit 13-11)

S =   mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S =   0.419 (Exhibit 13-12)

S_R =   52.5 mph (Exhibit 13-12)

S_0 =   60.4 mph (Exhibit 13-12)

S =   55.1 mph (Exhibit 13-13)

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F-4400

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

			Site Information	
Analyst	AJR		Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins		From/To	2195-Montagu Off to Montagu On
Date Performed	7/25/2014		Jurisdiction	
Analysis Time Period	AM Peak		Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2922	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	8	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.962

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1126   pc/h/ln

S   60.0   mph

D = v_p / S   18.8   pc/mi/ln

LOS   C

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4401

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins	From/To	2195-Montagu Off to Montagu On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	4504	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	6	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.971

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

		Design (N)	

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1718   pc/h/ln

S	59.7	mph
D = v_p / S	28.8	pc/mi/ln
LOS	D	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4402

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency/Company	Atkins	Weaving Segment Location	2200 - Montague to I-526 EB
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1920ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2490	0.90	8	0	1.5	1.2	0.962	1.00	2877
V_{RF}	389	0.90	25	0	1.5	1.2	0.889	1.00	486
V_{FR}	432	0.90	10	0	1.5	1.2	0.952	1.00	504
V_{RR}	67	0.90	25	0	1.5	1.2	0.889	1.00	84
V_{NW}	2961							V =	3951
V_W	990								
VR	0.251								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	990 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1392 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	880 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2272 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	455

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3951 pc/h	Weaving intensity factor, W	0.258
Weaving segment capacity, c_w	7923 veh/h	Weaving segment speed, S	48.8 mph
Weaving segment v/c ratio	0.479	Average weaving speed, S_W	50.8 mph
Weaving segment density, D	20.3 pc/mi/ln	Average non-weaving speed, S_{NW}	48.1 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5060 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4403

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency/Company	Atkins	Weaving Segment Location	2200 - Montague to I-526 EB
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1920ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4153	0.90	6	0	1.5	1.2	0.971	1.00	4753
V_{RF}	1164	0.90	8	0	1.5	1.2	0.962	1.00	1345
V_{FR}	351	0.90	9	0	1.5	1.2	0.957	1.00	408
V_{RR}	98	0.90	9	0	1.5	1.2	0.957	1.00	114
V_{NW}	4867							V =	6620
V_W	1753								
VR	0.265								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1753 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2155 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1273 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3428 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	748

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6620 pc/h	Weaving intensity factor, W	0.357
Weaving segment capacity, c_w	7953 veh/h	Weaving segment speed, S	41.4 mph
Weaving segment v/c ratio	0.808	Average weaving speed, S_W	48.2 mph
Weaving segment density, D	40.0 pc/mi/ln	Average non-weaving speed, S_{NW}	39.4 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5209 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4404

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information | Site Information

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2210-WB Off to I-526 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp

☐ Yes ☐ On
☑ No ☐ Off

L_{up} = ____ ft

V_u = ____ veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	830
Freeway Volume, V_F	2879
Ramp Volume, V_R	275
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes ☐ On
☑ No ☐ Off

L_{down} = ____ ft

V_D = ____ veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2879	0.90	Level	14	0	0.935	1.00	3423
Ramp	275	0.90	Level	7	0	0.966	1.00	316
UpStream								
DownStream								

Merge Areas	Diverge Areas

Estimation of v_{12} (Merge) | ### Estimation of v_{12} (Diverge)

Merge:

$$V_{12} = V_F (P_{FM})$$

L_{EQ} = ____ (Equation 13-6 or 13-7)
P_{FM} = ____ using Equation (Exhibit 13-6)
V_{12} = ____ pc/h
V_3 or V_{av34} ____ pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Diverge:

$$V_{12} = V_R + (V_F - V_R)P_{FD}$$

L_{EQ} = ____ (Equation 13-12 or 13-13)
P_{FD} = 0.660 using Equation (Exhibit 13-7)
V_{12} = 2366 pc/h
V_3 or V_{av34} 1057 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = ____ pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks (Merge)

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks (Diverge)

	Actual	Capacity	LOS F?
V_F	3423	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3107	Exhibit 13-8	6900	No
V_R	316	Exhibit 13-10	1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	2366	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F) (Merge)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$$

D_R = ____ (pc/mi/ln)
LOS = ____ (Exhibit 13-2)

Level of Service Determination (if not F) (Diverge)

$$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$$

D_R = 17.1 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination (Merge)

M_S = ____ (Exibit 13-11)
S_R = ____ mph (Exhibit 13-11)
S_0 = ____ mph (Exhibit 13-11)
S = ____ mph (Exhibit 13-13)

Speed Determination (Diverge)

D_S = 0.586 (Exhibit 13-12)
S_R = 49.4 mph (Exhibit 13-12)
S_0 = 65.6 mph (Exhibit 13-12)
S = 53.5 mph (Exhibit 13-13)

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F-4405

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		*Site Information*	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2210-WB Off to I-526 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site
Project Description	Navy Base ICTF		

Inputs

Upstream Adj Ramp			Downstream Adj Ramp	
☐ Yes ☐ On	Freeway Number of Lanes, N	3	☐ Yes ☐ On	
	Ramp Number of Lanes, N	1		
☑ No ☐ Off	Acceleration Lane Length, L_A		☑ No ☐ Off	
	Deceleration Lane Length L_D	830		
L_{up} = ft	Freeway Volume, V_F	5317	L_{down} = ft	
	Ramp Volume, V_R	338		
V_u = veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D = veh/h	
	Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5317	0.90	Level	11	0	0.948	1.00	6233
Ramp	338	0.90	Level	5	0	0.976	1.00	385
UpStream								
DownStream								

Merge Areas	**Diverge Areas**
### Estimation of v_{12}	### Estimation of v_{12}

Merge Areas	Diverge Areas
$V_{12} = V_F (P_{FM})$	$V_{12} = V_R + (V_F - V_R)P_{FD}$
L_{EQ} = (Equation 13-6 or 13-7)	L_{EQ} = (Equation 13-12 or 13-13)
P_{FM} = using Equation (Exhibit 13-6)	P_{FD} = 0.586 using Equation (Exhibit 13-7)
V_{12} = pc/h	V_{12} = 3815 pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)	V_3 or V_{av34} 2418 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No	Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No	Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)	If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity	LOS F?
V_{FO}		Exhibit 13-8	

Capacity Checks

	Actual	Capacity	LOS F?
V_F	6233	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5848	Exhibit 13-8	6900	No
V_R	385	Exhibit 13-10	1900	No

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
V_{R12}		Exhibit 13-8	

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
V_{12}	3815	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = 29.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R = mph (Exhibit 13-11)

S_0 = mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Speed Determination

D_s = 0.593 (Exhibit 13-12)

S_R = 49.3 mph (Exhibit 13-12)

S_0 = 60.3 mph (Exhibit 13-12)

S = 53.1 mph (Exhibit 13-13)

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F-4406

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins	From/To	2215- I-526 WB Off to EB&WB On
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	2604	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	14	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.935

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	3	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

$v_p = (V$ or DDHV$) / ($PHF x N x f_{HV} x f_p)

v_p	1032	pc/h/ln
S	60.0	mph
D = v_p / S	17.2	pc/mi/ln
LOS	B	

Design (N)

Design (N)

Design LOS

$v_p = (V$ or DDHV$) / ($PHF x N x f_{HV} x f_p)

v_p		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4407

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins	From/To	2215- I-526 WB Off to EB&WB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	4979	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	11	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.948

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	3		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures / Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1945   pc/h/ln

S   57.8   mph

D = v_p / S   33.6   pc/mi/ln

LOS   D

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4408

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 Build-River Center Site	Junction	On from 526 WB & EB
Analysis Time Period:	AM Peak	Segment ID	2218
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,112	3,508	1,396
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	10%	27%	53%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.88	0.79
Demand Flow Rate, v_p (pc/h/ln)	2,464	2,212	1,962
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	1.12	1.01	0.89
Density, D_{MD} (pc/mi/ln)	43.1	38.7	34.3
LOS	F	F	D

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$
HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$
HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$
HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 Build-River Center Site	Junction	On from 526 WB & EB
Analysis Time Period:	PM Peak	Segment ID	2218
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,442	4,123	1,681
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	20%	37%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.91	0.84
Demand Flow Rate, v_p (pc/h/ln)	2,808	2,520	2,213
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	1.28	1.15	1.01
Density, D_{MD} (pc/mi/ln)	49.1	44.1	38.7
LOS	F	F	F

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency/Company	Atkins	Weaving Segment Location	2220 - 526 to Rem/Aviation C-D
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	AM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2285ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1988	0.90	14	0	1.5	1.2	0.935	1.00	2364
V_{RF}	2679	0.90	27	0	1.5	1.2	0.881	1.00	3379
V_{FR}	616	0.90	14	0	1.5	1.2	0.935	1.00	732
V_{RR}	829	0.90	27	0	1.5	1.2	0.881	1.00	1045
V_{NW}	3409							V =	7520
V_W	4111								
VR	0.547								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	353

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	7520 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	5983 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.175	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	6811 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4411

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency/Company	Atkins	Weaving Segment Location	2220 - 526 to Rem/Aviation C-D
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2285ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4376	0.90	11	0	1.5	1.2	0.948	1.00	5130
V_{RF}	3624	0.90	20	0	1.5	1.2	0.909	1.00	4429
V_{FR}	603	0.90	11	0	1.5	1.2	0.948	1.00	707
V_{RR}	499	0.90	20	0	1.5	1.2	0.909	1.00	610
V_{NW}	5740							V =	10876
V_W	5136								
VR	0.472								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	10876 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	7025 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.467	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	5938 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-4412

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB
Agency or Company	Atkins	From/To	2225- Rem/Avia CD Off to CD On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	4667	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	16	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.926

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	4		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	60.0	mph	FFS	60.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1400   pc/h/ln

S	60.0	mph
D = v_p / S	23.3	pc/mi/ln
LOS	C	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S	mph
D = v_p / S	pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8

E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9

f_p - Page 11-18   TRD - Page 11-11

LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information

Analyst	AJR		
Agency or Company	Atkins		
Date Performed	7/25/2014		
Analysis Time Period	PM Peak		

Site Information

Highway/Direction of Travel	I-26 WB
From/To	2225- Rem/Avia CD Off to CD On
Jurisdiction	
Analysis Year	2038 Build - River Center Site

Project Description *Navy Base ICTF*

☑ Oper.(LOS)　　　☐ Des.(N)　　　☐ Planning Data

Flow Inputs

Volume, V	8000	veh/h
AADT		veh/day
Peak-Hr Prop. of AADT, K		
Peak-Hr Direction Prop, D		
DDHV = AADT x K x D		veh/h

Peak-Hour Factor, PHF	0.90	
%Trucks and Buses, P_T	13	
%RVs, P_R	0	
General Terrain:	Level	
Grade　%	Length	mi
Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R		1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$		0.939

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	4	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	60.0	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	60.0	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	2367	pc/h/ln
S	49.3	mph
D = v_p / S	48.0	pc/mi/ln
LOS	F	

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

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F-4414

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2038 Build-River Center Site	Junction	WB Off to Remount
Analysis Time Period:	AM Peak	Segment ID	2230
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,445	839	606
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	4%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.98
Demand Flow Rate, v_p (pc/h/ln)	823	951	690
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.37	0.43	0.33
Density, D_{MD} (pc/mi/ln)	14.4	16.6	12.1
LOS	B	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2038 Build-River Center Site	Junction	WB Off to Remount
Analysis Time Period:	PM Peak	Segment ID	2230
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,102	547	555
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	5%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.98
Demand Flow Rate, v_p (pc/h/ln)	628	623	632
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.29	0.28	0.30
Density, D_{MD} (pc/mi/ln)	11.0	10.9	11.1
LOS	B	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2235-Remount Off to Remount On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 Build - River Center Site*

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*1678*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ *951*   pc/h/ln

S	*55.0*	mph
$D = v_p / S$	*17.3*	pc/mi/ln
LOS	*B*	

Design (N)

Design LOS

$v_p = (V \text{ or } DDHV) / (PHF \times N \times f_{HV} \times f_p)$ pc/h/ln

S		mph
$D = v_p / S$		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   2:44 PM

F-4417

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB C-D
Agency or Company	Atkins	From/To	2235-Remount Off to Remount On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   Navy Base ICTF

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1094	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	5	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.976

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   623   pc/h/ln

S   55.0   mph

D = v_p / S   11.3   pc/mi/ln

LOS   B

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010™   Version 6.41   Generated: 12/9/2014   2:45 PM

F-4418

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB C-D
Weaving Segment Location	2240 - Remount to Aviation
Analysis Year	2038 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	2		
Weaving segment length, L_S	750ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	55 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	261	0.90	18	0	1.5	1.2	0.917	1.00	316
V_{FR}	839	0.90	4	0	1.5	1.2	0.980	1.00	951
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	1267
V_W	1267								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1267 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1320 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	21 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1341 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1267 pc/h	Weaving intensity factor, W	0.357
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	44.5 mph
Weaving segment v/c ratio	0.528	Average weaving speed, S_W	44.5 mph
Weaving segment density, D	14.2 pc/mi/ln	Average non-weaving speed, S_{NW}	42.8 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   2:45 PM

F-4419

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information		Site Information	
Analyst	AJR	Freeway/Dir of Travel	I-26 WB C-D
Agency/Company	Atkins	Weaving Segment Location	2240 - Remount to Aviation
Date Performed	7/25/2014	Analysis Year	2038 Build - River Center Site
Analysis Time Period	PM Peak		

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	2		
Weaving segment length, L_S	750ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	55 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	951	0.90	4	0	1.5	1.2	0.980	1.00	1078
V_{FR}	547	0.90	5	0	1.5	1.2	0.976	1.00	623
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	1701
V_W	1701								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1701 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1754 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	21 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1775 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1701 pc/h	Weaving intensity factor, W	0.446
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	42.7 mph
Weaving segment v/c ratio	0.709	Average weaving speed, S_W	42.7 mph
Weaving segment density, D	19.9 pc/mi/ln	Average non-weaving speed, S_{NW}	38.7 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   2:46 PM

F-4420

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		*Site Information*	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2245 - Avia Off to Avia EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 Build - River Center Site*

Project Description	*Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	*522*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*18*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R		*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$		*0.917*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Design (N)

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   *316*   pc/h/ln

S	*55.0*	mph
D = v_p / S	*5.7*	pc/mi/ln
LOS	*A*	

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes	S - Speed
V - Hourly volume	D - Density
v_p - Flow rate	FFS - Free-flow speed
LOS - Level of service	BFFS - Base free-flow speed
DDHV - Directional design hour volume	

Factor Location

E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
f_p - Page 11-18	TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3	

HCS 2010[TM]   Version 6.41   Generated: 12/9/2014   2:46 PM

F-4421

BASIC FREEWAY SEGMENTS WORKSHEET

General Information

		Site Information	
Analyst	AJR	Highway/Direction of Travel	I-26 WB C-D
Agency or Company	Atkins	From/To	2245 - Avia Off to Avia EB On
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 Build - River Center Site

Project Description   *Navy Base ICTF*

☑ Oper.(LOS)   ☐ Des.(N)   ☐ Planning Data

Flow Inputs

Volume, V	1902	veh/h	Peak-Hour Factor, PHF	0.90	
AADT		veh/day	%Trucks and Buses, P_T	4	
Peak-Hr Prop. of AADT, K			%RVs, P_R	0	
Peak-Hr Direction Prop, D			General Terrain:	Level	
DDHV = AADT x K x D		veh/h	Grade % Length	mi	
			Up/Down %		

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	0.980

Speed Inputs

			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	2		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	55.0	mph	FFS	55.0	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   1078   pc/h/ln

S   55.0 mph

D = v_p / S   19.6   pc/mi/ln

LOS   C

Design (N)

Design (N)

Design LOS

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)   pc/h/ln

S   mph

D = v_p / S   pc/mi/ln

Required Number of Lanes, N

Glossary

N - Number of lanes   S - Speed
V - Hourly volume   D - Density
v_p - Flow rate   FFS - Free-flow speed
LOS - Level of service   BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12 f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13 f_{LC} - Exhibit 11-9
f_p - Page 11-18   TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

HCS 2010™ Version 6.41   Generated: 12/9/2014   2:47 PM

F-4422

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ΛTKINS

General Information

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	261	281	20
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	18%	19%	25%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.92	0.91	0.89
Demand Flow Rate, v_p (pc/h/ln)	316	342	25
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.14	0.16	0.01
Density, D_{MD} (pc/mi/ln)	5.5	6.0	0.4
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)} \qquad \text{HCM 2010, Equation 11-3}$$

$$V_p = \frac{V}{PHF \cdot N \cdot f_{HV} \cdot f_P} \qquad \text{HCM 2010, Equation 11-2}$$

$$D_{MD} = \frac{0.0175 \cdot v_f}{N} \qquad \text{HCM 2010, Equation 13-26}$$

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)
ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2038 Build-River Center Site	Junction	WB On from Aviation EB
Analysis Time Period:	PM Peak	Segment ID	2250
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	951	1,335	384
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,078	1,506	431
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.49	0.68	0.23
Density, D_{MD} (pc/mi/ln)	18.9	26.4	7.5
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T\text{-}1)+P_R(E_R\text{-}1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2038 Build-River Center Site	Junction	WB On from Aviation WB
Analysis Time Period:	AM Peak	Segment ID	2260
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	281	379	98
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	19%	21%	27%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.91	0.90	0.88
Demand Flow Rate, v_p (pc/h/ln)	342	465	124
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.16	0.21	0.06
Density, D_{MD} (pc/mi/ln)	6.0	8.1	2.2
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)
ΛTKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2038 Build-River Center Site	Junction	WB On from Aviation WB
Analysis Time Period:	PM Peak	Segment ID	2260
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,335	1,834	499
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	4%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,506	2,079	566
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.68	0.95	0.27
Density, D_{MD} (pc/mi/ln)	26.4	36.4	9.9
LOS	C	E	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF \cdot N \cdot f_{HV} \cdot f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175 \cdot v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

F-4426

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 Build-River Center Site	Junction	From Rem/Aviation C-D
Analysis Time Period:	AM Peak	Segment ID	2270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Off-Ramp	Freeway Downstream of Off-Ramp	Off-Ramp
Number of Lanes, N	4	5	1
Free-Flow Speed, FFS (mph)	60	60	55
Volume, V (veh/h)	4,667	5,046	379
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	16%	16%	21%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.93	0.93	0.90
Demand Flow Rate, v_p (pc/h/ln)	1,400	1,211	465
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,200
v/c ratio	0.61	0.53	0.21
Density, D_{MD} (pc/mi/ln)	24.5	21.2	8.1
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 Build-River Center Site	Junction	From Rem/Aviation C-D
Analysis Time Period:	PM Peak	Segment ID	2270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	5	1
Free-Flow Speed, FFS (mph)	60	60	55
Volume, V (veh/h)	8,000	9,834	1,834
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	13%	12%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.94	0.98
Demand Flow Rate, v_p (pc/h/ln)	2,367	2,316	2,079
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,200
v/c ratio	1.03	1.01	0.95
Density, D_{MD} (pc/mi/ln)	41.4	40.5	36.4
LOS	F	F	E

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+ P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments
Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max
Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
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Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
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Source: HCM 2010, Exhibit 13-2